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ABSTRACT

The purpose of this document is to present a final description of the original MEDLARS system as it evolved through four years of operation. The system is described as it was functioning on January 1, 1968. Among the various system elements discussed are: (1) the input subsystem, including journal selection and coverage, Medical Subject Headings (MeSH), and indexing; (2) the retrieval subsystem, including request analysis, search formulation, file search, and printout of retrieved citations; and (3) the publication subsystem, including the MEDLARS photocomposer and computer programs for producing MEDLARS publications. A summary of operating experience for the period includes discussion of system problems, changes, and evaluation. Also discussed is the extension of MEDLARS technology to the cataloging of books and serial titles. This system produces two major products: (1) catalog cards for the central NLM card catalog and (2) the NLM current catalog, a computer-produced book-form catalog available to other medical libraries on a current and frequent basis for use as an acquisitions and cataloging tool. Appended is a list of approximately 200 selected references. (JW)

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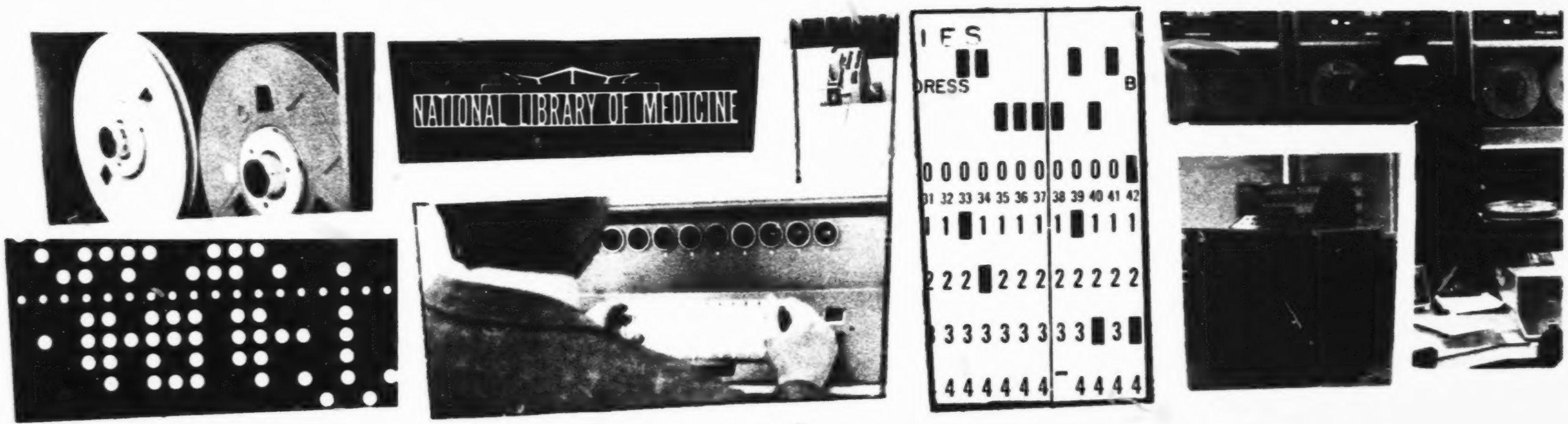
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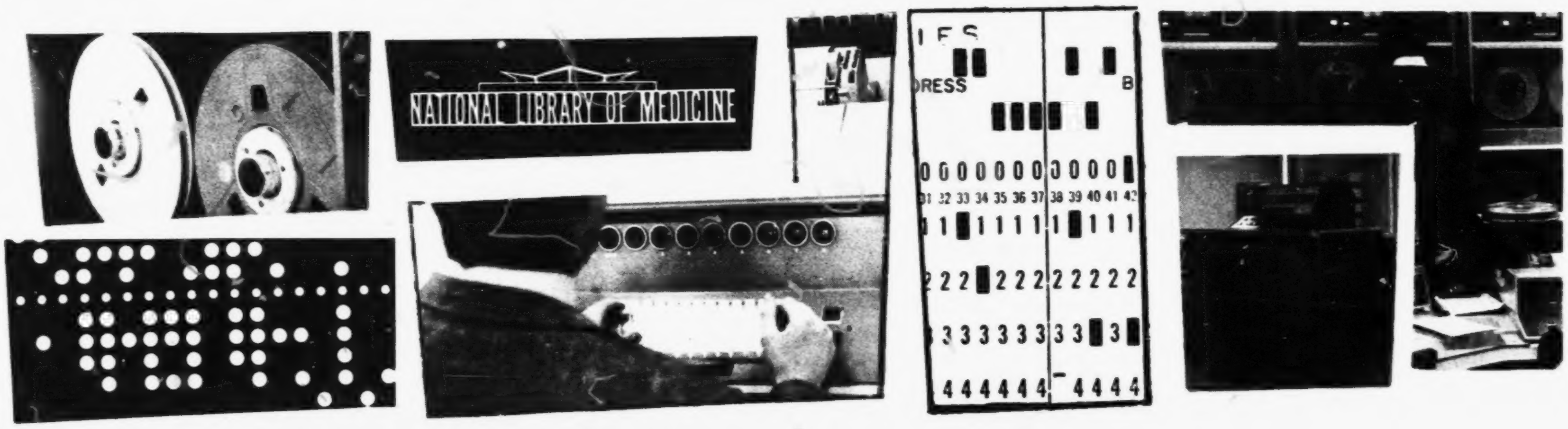

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MEDLARS

1963–1967

BY CHARLES J. AUSTIN

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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FOREWORD

At the National Library of Medicine, we regard the sharing of information with other workers in the field of information retrieval, documentation, and library science as one of our most important responsibilities. In accordance with this philosophy, we are reporting here the experience gained from more than four years' operation of a large-scale reference storage and retrieval system, MEDLARS.

I believe that Mr. Charles Austin's report describes our experiences, both good and bad, with objectivity. No attempt has been made to minimize the mistakes which were made during this experiment. There is a frank discussion of how well system objectives have been met.

The Library is currently in the process of designing a new system to replace MEDLARS. We earnestly hope that this final description of our first computer-based system will be helpful to others entering this field. We hope also that the lessons we have learned from actually operating MEDLARS will be valuable to us as we move ahead toward applying more advanced techniques of information processing. The documentation of the experiences of others, added to our own, should provide information of great value to the managers as well as the users of computer-based information storage and retrieval systems.

Martin M. Cummings, M.D.
Director
National Library of Medicine

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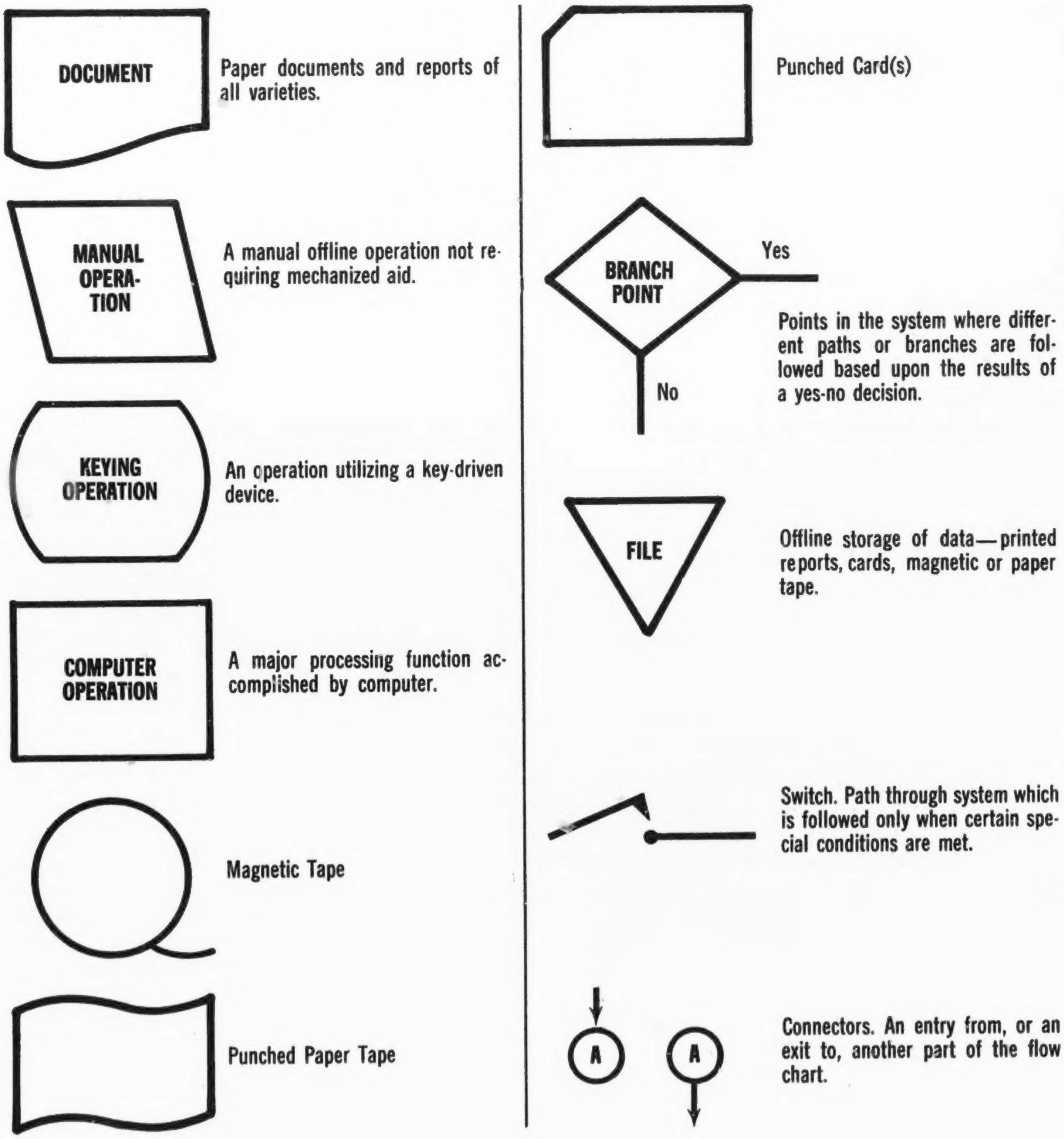
DOCUMENT
MANUAL OPERATION
KEYING OPERATION
COMPUTER OPERATION
BRANCH POINT
Yes
No
FILE
A
A

Paper documents and reports of all varieties.

A manual offline operation not requiring mechanized aid.

An operation utilizing a key-driven device.

A major processing function accomplished by computer.

Magnetic Tape

Punched Paper Tape

Punched Card(s)

Points in the system where different paths or branches are followed based upon the results of a yes-no decision.

Offline storage of data—printed reports, cards, magnetic or paper tape.

Switch. Path through system which is followed only when certain special conditions are met.

Connectors. An entry from, or an exit to, another part of the flow chart.

Figure 1.—*Definition of Flow Charting Symbols.*

Chapter I

INTRODUCTION

In January 1964, after three years of detailed planning and system development, the National Library of Medicine initiated MEDLARS (Medical Literature Analysis and Retrieval System). The original system design was described in detail in *The MEDLARS Story** published in 1963. Various references to the system as it developed can be found in the bibliography of this report.

The purpose of this document is to present a final description of the system as it has evolved through a period of four years of operation. This will add the final chapter to the present MEDLARS story at a time when the Library is on the threshold of developing an entirely new system, utilizing the latest techniques of documentation and information science coupled with modern, "third-generation" computer equipment.

The reader interested in a complete chronicle of the Library's experience with MEDLARS is advised to combine the reading of this report with a re-reading of the original MEDLARS story. Thus he will be able to develop a complete picture that answers the questions: (1) What did the Library set out to do? (2) What was actually accomplished? and (3) What changes were made in the original system design and why?

MEDLARS is a dynamic system which is constantly changing; therefore, any system description must necessarily reflect only a snapshot view of a rapid motion picture. This report describes the system as it was functioning on January 1, 1968. Although some additional changes will be made before the new "third-generation" system goes into production, this point in time is adequate to describe, at least in general terms, the "final" version of the original MEDLARS.

In addition to describing the final picture of MEDLARS as it evolved over the years, this report emphasizes the changes made during the evolutionary process. Problems encountered and unmet objectives are frankly discussed in recounting the MEDLARS experience. The formal evaluation of MEDLARS conducted during 1966 and 1967 adds to the reservoir of data collected on system performance. It is hoped that this detailed reporting on the Library's experience will assist others involved in the design and operation of information retrieval systems.

Background and History

The information which MEDLARS processes and disseminates consists of references to published medical literature. Effective utilization of published literature requires bibliographic control through descriptive and subject indexing of individual books and journal articles.

The Library initiated its program of bibliographic control of the medical literature in 1879 with publication of the first issue of *Index Medicus*, which continued until 1927 (see Figure 2). Replaced from 1927 to 1956 by the *Quarterly Cumulative Index Medicus,* published by the American Medical Association, *Index Medicus* reappeared as a Library publication in 1960, replacing the monthly *Current List of Medical Literature.*

From 1960 to 1963, *Index Medicus* was produced by a partially mechanized system that utilized paper tape typewriters, punched

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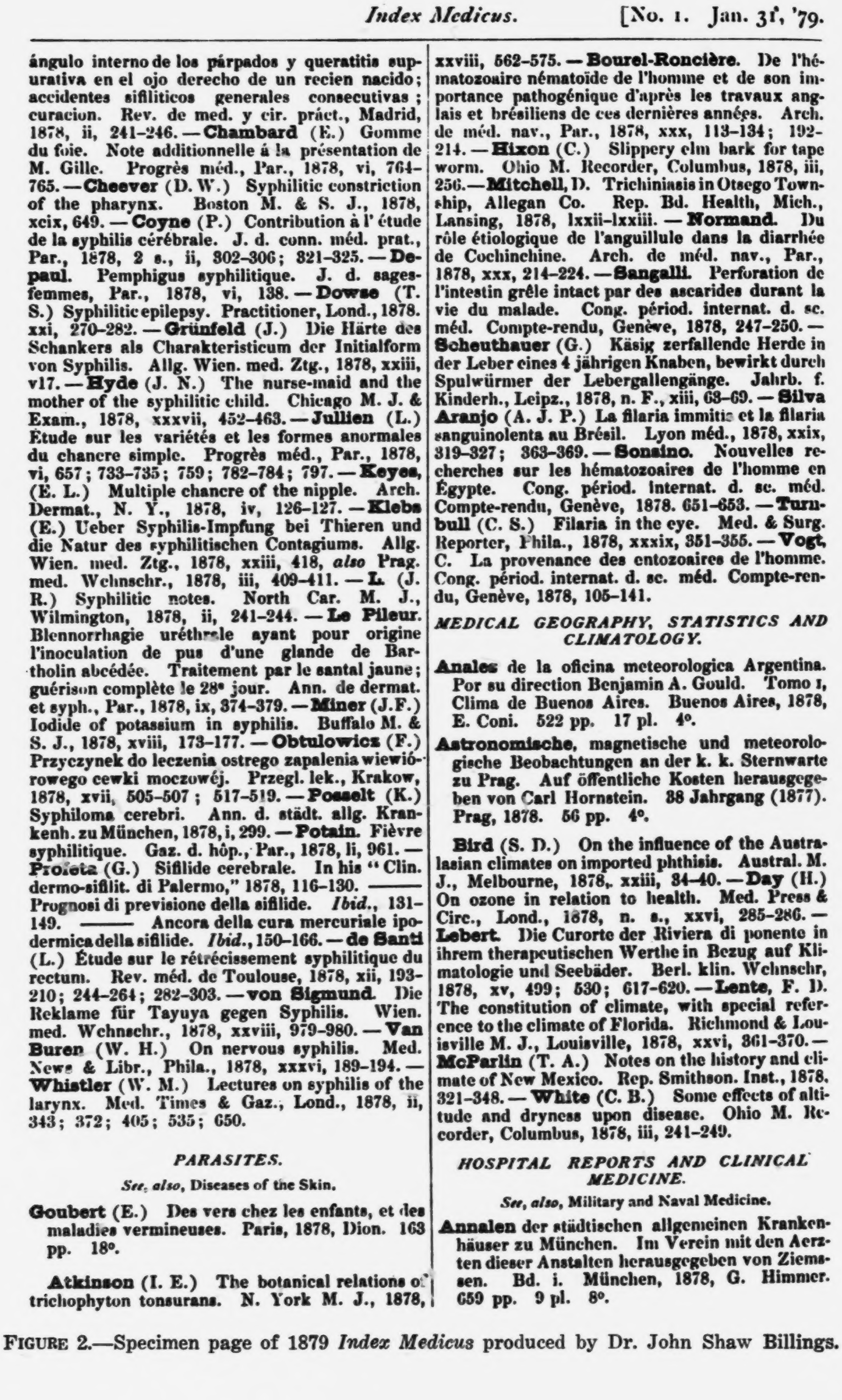
**The MEDLARS Story at the National Library of Medicine*, U.S. Dept. of Health, Education, and Welfare, Public Health Service, Bethesda, Maryland, 1963.



Index Medicus. [No. 1. Jan. 31, '79.

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Anales de la oficina meteorologica Argentina. Por su direction Benjamin A. Gould. Tomo I, Clima de Buenos Aires. Buenos Aires, 1878, E. Coni. 522 pp. 17 pl. 4°.

Astronomische, magnetische und meteorologische Beobachtungen an der k. k. Sternwarte zu Prag. Auf öffentliche Kosten herausgegeben von Carl Hornstein. 38 Jahrgang (1877). Prag, 1878. 56 pp. 4°.

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HOSPITAL REPORTS AND CLINICAL MEDICINE.

See, also, Military and Naval Medicine.

Annalen der städtischen allgemeinen Krankenhäuser zu München. Im Verein mit den Aerzten dieser Anstalten herausgegeben von Ziemssen. Bd. i. München, 1878, G. Himmer. 659 pp. 9 pl. 8°.

FIGURE 2.—Specimen page of 1879 *Index Medicus* produced by Dr. John Shaw Billings.

card equipment, and a Listomatic Camera.* Operation of the Listomatic System greatly aided in the subsequent development of MEDLARS, since: (1) the earlier system provided much background data used in the design of MEDLARS; (2) it offered a valuable operating experience on which to base the system design; and (3) it assisted in the data conversion task for MEDLARS, since some bibliographic data had already been put in machine-readable form for the Listomatic process.

Although the Listomatic Camera System worked effectively in the publication of *Index Medicus* and related publications, it had limitations. Perhaps the most serious of these was the very limited information retrieval capability. The large number of punched cards accumulated for only one year's publication precluded any effective information retrieval using punched card equipment (about ½ million new cards each year).

Primarily because of these limitations of the Listomatic System, and also because of the rapidly growing size of *Index Medicus,* the Library decided to begin planning a new and more highly mechanized system. Using both outside consultants and members of the staff, a set of overall system requirements was prepared in early 1961. Because of limited technical capability of the staff, a decision was made to use an outside contractor for the detailed design and implementation of the new system. Bidding and evaluation of contractors' submissions occurred during the first six months of 1961, and a contract was awarded to the General Electric Company, Information Systems Operation, Bethesda, Maryland.

Phase I of the contract (from mid-August to December 1961) resulted in a set of preliminary system specifications including an overall system plan, computer programming requirements, and evaluation and selection of major equipment required for the system.†

Phase II and Phase III of the contract (January 1962–December 1963) included detailed design and pre-production activities. The major tasks were: (1) computer programming and testing; (2) procedure writing; (3) ordering and installation of equipment; (4) recruiting and staffing of personnel to operate and maintain the system; (5) conversion and final system testing prior to production (scheduled for January 1964).

The conversion period ran from April to December 1963. After installation of the computer in March 1963, approximately 45,000 journal article citations from the 1963 *Index Medicus* were converted to magnetic tape. During this same period new personnel were added to the Library staff, and an extensive system test was carried out. Cut-over to the new system was accomplished in January 1964, and it has been in operation continuously since that date.

System Objectives

The major objectives for the MEDLARS system as stated by Library management in 1961 are listed below:

(1) Improve the quality of and enlarge (broaden the scope of) *Index Medicus* and at the same time reduce the time required to prepare the monthly edition for printing from 22 to 5 working days.

(2) Make possible the production of other compilations similar to *Index Medicus* in form and content (but in more specific medical subject areas and hence smaller in size).

(3) Make possible, for *Index Medicus* and other compilations, the inclusion of citations derived from other sources, as well as from journal articles.

(4) Make possible the prompt (a maximum of two days) and efficient servicing of requests for special bibliographies, on both a demand and a recurring basis, regularly searching up to five years of stored computer files.

(5) Increase the average depth of indexing per article (number of descrip-

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*For an excellent description of the Listomatic System see: S. I. Taine, The National Library of Medicine Index Mechanization Project, *Bulletin of the Medical Library Ass.,* 49: No. 1, Pt. 2, (Jan. 1961).

†General Electric Co., *Final Report of Phase I: Preliminary Design,* Bethesda, Maryland, 1962.

tive subject terms per article) by a factor of five, i.e., ten headings versus two.

(6) Nearly double the number of articles that may be handled (indexed and entered into the computer) annually—from 140,000 now to 250,000 in 1969.

(7) Reduce the need for duplicative total literature screening operations (at other libraries and information centers).

(8) Keep statistics and perform analyses of its own operations to provide the information needed to monitor and improve system effectiveness.

(9) Permit future expansion to incorporate new and as yet not completely defined—and hence secondary—objectives.

Some of these objectives were quite realistic and have been effectively accomplished. Others turned out to be difficult or not feasible at the time, and have met with only limited success. A more complete discussion of how objectives have been accomplished is contained in Chapter VII, Operating Experience.

Design Criteria

Although it is a generally accepted principle of systems design that the designer should operate with as few predetermined constraints on his imagination as possible, nonetheless, a large-scale, operational system such as MEDLARS usually requires that some "ground rules" be established in advance.

Some of the major guiding principles on which the design of MEDLARS was based are discussed below.

First, and perhaps most important, was a decision to continue to use human indexers for assigning subject descriptors to the literature for subsequent retrieval and publication of references. Library staff and the contractor both agreed that the state of the art of automatic indexing in 1961 was such that it was not feasible for MEDLARS. A second important and closely related decision was to continue to use a controlled vocabulary for indexing, rather than experiment with natural language or other "open-ended" indexing approaches, none of which had ever been used in a large production system.

Another major decision was to index each article only once, and use a single computer input record both for publication in *Index Medicus* and for retrieval purposes. This policy, which was adopted for economic reasons, has not been without its problems in requiring compromises in actual operation of the system.

Other important design criteria included:

(1) A decision to train search specialists for formulating retrieval requests for the computer, rather than allow customers of the system to attempt to formulate their own computer search statements.

(2) A decision to use serial magnetic tape files for storing journal article citations, rather than random access devices. This decision was reached after a careful analysis of comparative costs and retrieval efficiency based upon equipment available in 1961–62.

(3) A decision to segment computer programs into self-contained "modules" for ease of maintenance and system changes.

(4) A requirement that the system employ a "high-quality" output device, superior to available computer printers, for preparation of copy for MEDLARS publications. This requirement led to an extensive study of possible output devices, and a subsequent decision that the Library must develop a high-speed, high-quality photocomposition device. The decision was a truly momentous one—both for its impact on MEDLARS and the photocomposition industry in general!

(5) A decision not to increase the amount of clerical work required of the professional indexer by using clerical personnel for preparation of the computer input record. It was decided also to design the system so as to use the computer for as much coding and editing of the input data as possible.

Chapter II

SYSTEM DESCRIPTION

Major Products of the System

The products of MEDLARS can be divided into two major categories: (1) *bibliographic publications* designed for use by a large group of people working in related fields; and (2) individual *demand searches* of the literature tailored to the stated requirements of an individual or small group of people working on the same project.

Publications produced by MEDLARS as of January 1, 1968 are listed in Table 1. The first six publications are general reference works used in medical libraries throughout the world. The last nine are more specialized recurring bibliographies produced in a variety of formats in cooperation with professional societies and other government agencies working in the specialty fields. These cooperating organizations provide assistance and guidance in setting up the bibliography, and take responsibility for printing and distribution to workers in the specialty field.

Demand searches are individually formulated to meet the specifications of the requester. The bibliographies produced as a result of the search are printed either on 3″ x 5″ cards or on continuous computer tabulating paper. The content of these demand bibliographies ranges from a few articles in a very specialized field, to a broad review of the literature for someone looking for a comprehensive listing of everything related to his field of interest. Some sample demand bibliographies are shown in Figure 3.

Professional staff of the Library sometimes formulate demand searches for an individual which, they believe, may be of broader interest to others. These bibliographies are reprinted in high-quality format as "Literature Searches" and copies are sent to anyone upon request. Updated lists of Literature Searches are regularly printed in *Public Health Reports, Journal of the American Medical Association, Journal of the American Dental Association,* and *Drug Research Reports;* announcements are also published in other major journals and the bibliographies are widely circulated at professional meetings. (A complete list of current Literature Searches is available from the Library's Office of Public Information.)

In addition to publications and demand searches, MEDLARS also produces internal reports used by operating and management personnel. These include such things as operating statistics and print-outs of computer files. Figure 4 is a sample statistical report showing the frequency of usage of Medical Subject Headings (MeSH).

Overall Data Flow

The data flow through MEDLARS can best be understood by referring to the flow chart in Figure 5.

The system can be described functionally as consisting of three major parts: an Input Subsystem, a Retrieval Subsystem, and a Publication Subsystem.

The Input Subsystem combines the intellectual talents of trained literature analysts with the processing and storage capabilities of the computer. New medical journals are checked in and forwarded to the Index Section, where the analysts classify the subject content of each article in the journals by assigning appropriate descriptors from the Library's controlled list of terms (*Medical Subject Headings*). The indexers are respon-

TABLE 1.—*MEDLARS Publications* (as of January 1, 1968)

Name	Description	Frequency	Cooperating Organization
Index Medicus	Comprehensive listing of articles indexed—major library reference tool. Subject & author listings; separate section listing review articles	Monthly	------
Cumulated Index Medicus	Cumulation of monthly issues—subject cross references added; no review section; journals indexed for *Index Medicus* are listed	Annual	------
Medical Subject Headings	Alphabetic and categorized list of subject headings used in MEDLARS indexing. Published as Part II of January issue of *Index Medicus*	Annual	------
List of Journals Indexed in Index Medicus	Journals indexed for *Index Medicus* listed by title abbreviation, full title, major subject areas, & country of origin	Annual	------
Monthly Bibliography of Medical Reviews	Listing of review articles in monthly *Index Medicus;* subject and author sections. Cumulated annually in *CIM.*	Monthly	------
NLM Current Catalog	List of books, serials, and reports cataloged; subject and author listings	Biweekly with quarterly cumulations	------
RECURRING BIBLIOGRAPHIES:			
Cerebrovascular Bibliography	Subject bibliography with separate subject and author indexes	Quarterly	National Institute of Neurological Diseases & Blindness & Nat'l Heart Institute
Fibrinolysis, Thrombolysis, and Blood Clotting	Subject and author sections, reviews, subject and author indexes	Monthly	National Heart Institute
Index of Rheumatology	Subject and author sections	Monthly	American Rheumatism Association
Index to Dental Literature	Subject & author sections; some additional journals not included in *Index Medicus* are indexed for this publication	Quarterly	American Dental Association
International Nursing Index	Subject & name sections; some additional journals not included in *Index Medicus* are indexed for this publication	Quarterly	American Journal of Nursing Company
Artificial Kidney Bibliography	Articles listed by broad subject area; bibliography is still being tested prior to general publication and release	Quarterly	National Institute of Arthritis & Metabolic Diseases
Medical Education Bibliography	Published as a regular section of the *Journal of Medical Education*	Monthly	Amer. Association of Medical Colleges

(Continued)

TABLE 1.—*continued.*

Name	Description	Frequency	Cooperating Organization
Bibliography of Endocrinology	Subdivided into major subject categories and author section with separate subject and author indexes	Bimonthly	National Institute of Arthritis and Metabolic Diseases
Surgery of the Hand	Subject and author sections	Quarterly	Amer. Society for Surgery of the Hand

sible also for translation of foreign titles, and a trained clerk transliterates titles of articles written in non-Latin alphabets. Journals with indexer data sheets attached are forwarded to the Input Section, where clerk-typists prepare punched paper tape input for the computer. The basic unit record consists of the article's title, author names, journal reference, and subject headings assigned by the indexer. The punched paper tape is accompanied by typewritten copy that is sight-verified by a staff of proofreaders. Once a day, all corrected paper tapes are batched and spliced together for entry into the computer.

The input computer programs accept the paper tape, edit the data extensively, and prepare the major data file—the Compressed Citation File (CCF). The Compressed Citation File is a highly coded, time-sequential store of citations used for searching and retrieval, both for individual demand searches and for MEDLARS publications.

The Retrieval Subsystem begins with the receipt of a request for a demand bibliography. Such requests are forwarded to a staff of search specialists who have had extensive training in both indexing and the logic of a computer search. These specialists formulate the request into a list of search parameters linked in logical fashion by up to three search statements. The formulated search requests are punched into cards and batched for daily computer processing. The search and retrieval programs match a batch of search questions against every record in the Compressed Citation File. Citations retrieved are printed in any one of a variety of output formats by means of print programs. The resulting lists of citations are referred to as "demand bibliographies."

The Publication Subsystem is concerned with preparation of periodic indexes to current biomedical literature. In accordance with a publication schedule, search specification cards are entered into the computer for bibliographies to be compiled. The search and retrieval programs retrieve the appropriate citations from the CCF. The publication format programs perform a rather complicated task of page composition and prepare a magnetic tape file of one-line print records for a computer phototypesetter.This tape is used to convert the digital information from magnetic tape to characters on photographic film or paper. The exposed film or paper is developed by an automatic processor, inspected, cut into page-size sheets, and packaged for mailing to the printer. The resulting typeset pages then can be used directly for printing the final publication.

Chapters III, IV, and V describe the three major subsystems in greater detail.

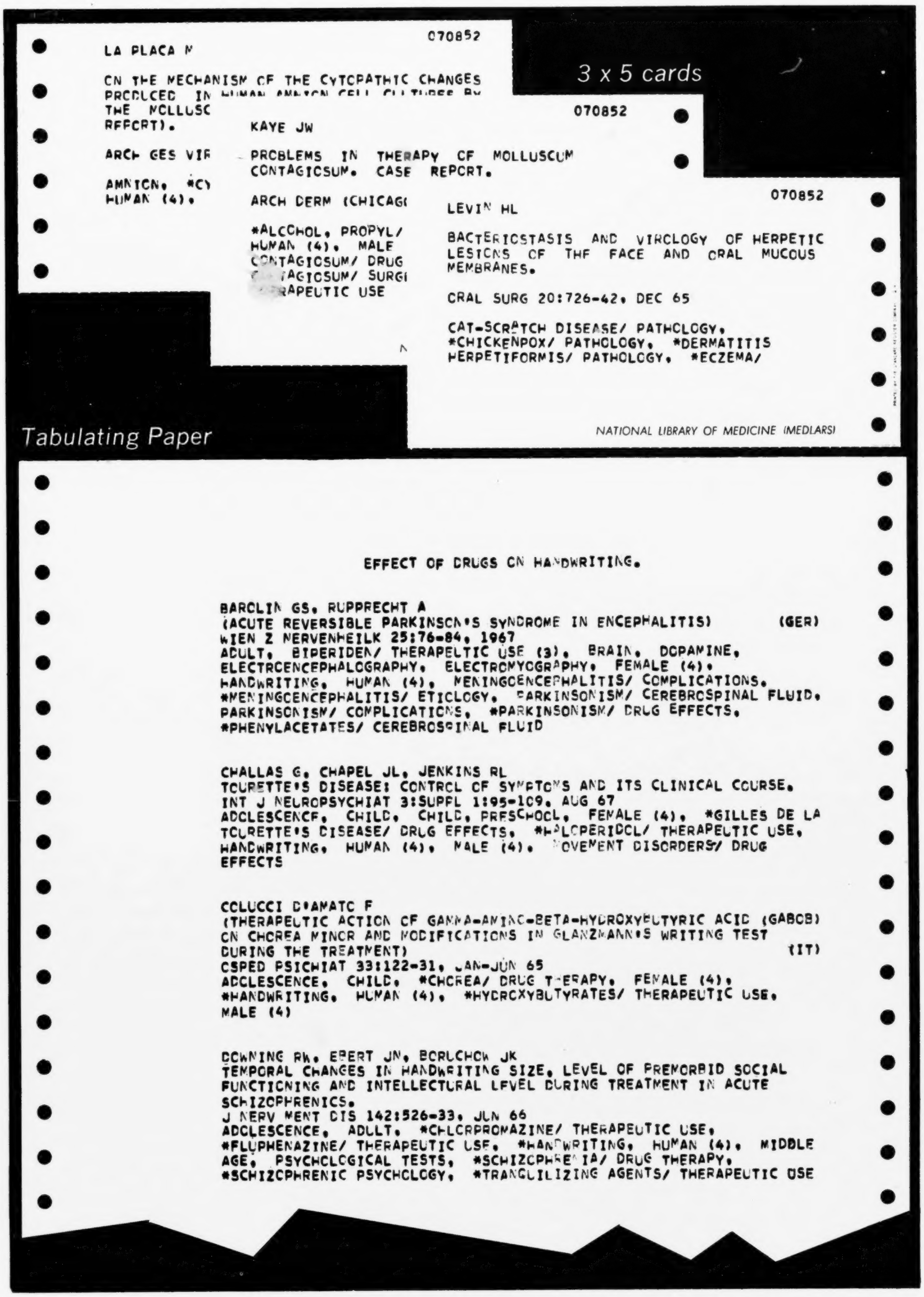
In addition to the major data flow described above, the system also employs various utility programs for updating of master files and preparation of statistical reports used for management control. These utility programs are described in Chapter VI.

Equipment

Table 2 shows the data processing and related equipment used in MEDLARS.

Input equipment includes paper tape typewriters for punching indexed citations, and punched card equipment for preparing cards used for demand searches, updating of master files, and initial entry of computer programs.

Current computer equipment includes a Honeywell-800 computer used for main pro-



3 x 5 cards
Tabulating Paper

```
                                        070852
LA PLACA M

ON THE MECHANISM OF THE CYTOPATHIC CHANGES
PRODUCED IN HUMAN AMNION CELL CULTURES BY
THE MOLLUSC
REPORT).

ARCH GES VIR

AMNION, *CY
HUMAN (4).
```

```
                                        070852
KAYE JW

PROBLEMS IN THERAPY OF MOLLUSCUM
CONTAGIOSUM. CASE REPORT.

ARCH DERM (CHICAGO

*ALCOHOL, PROPYL/
HUMAN (4), MALE
CONTAGIOSUM/ DRUG
  TAGIOSUM/ SURGI
  RAPEUTIC USE
```

```
                                        070852
LEVIN HL

BACTERIOSTASIS AND VIROLOGY OF HERPETIC
LESIONS OF THE FACE AND ORAL MUCOUS
MEMBRANES.

ORAL SURG 20:726-42, DEC 65

CAT-SCRATCH DISEASE/ PATHOLOGY,
*CHICKENPOX/ PATHOLOGY, *DERMATITIS
HERPETIFORMIS/ PATHOLOGY, *ECZEMA/

                    NATIONAL LIBRARY OF MEDICINE (MEDLARS)
```

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                 EFFECT OF DRUGS ON HANDWRITING.

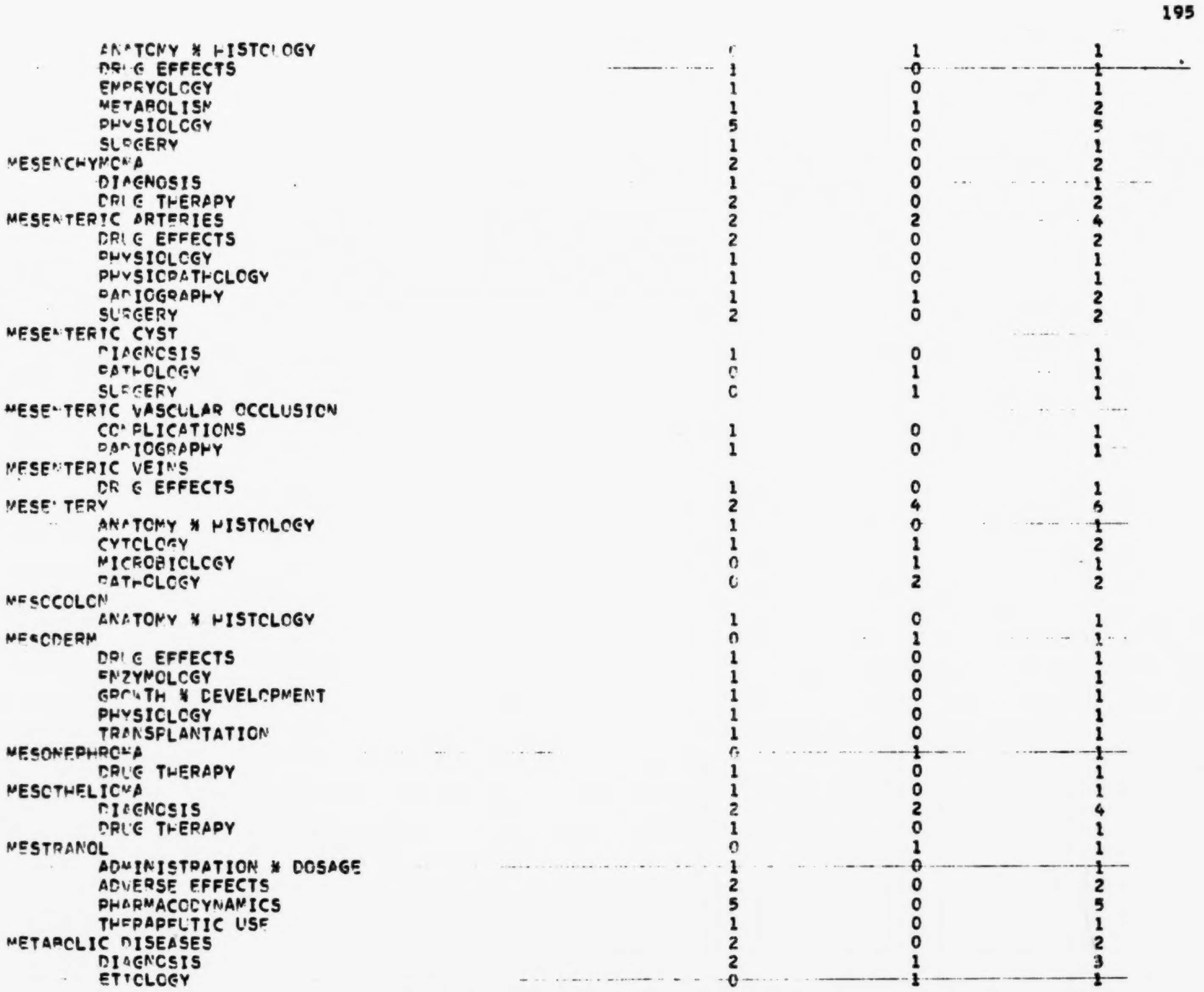
BAROLIN GS, RUPPRECHT A
(ACUTE REVERSIBLE PARKINSON'S SYNDROME IN ENCEPHALITIS)        (GER)
WIEN Z NERVENHEILK 25:76-84, 1967
ADULT,  BIPERIDEN/ THERAPEUTIC USE (3),  BRAIN,  DOPAMINE,
ELECTROENCEPHALOGRAPHY,  ELECTROMYOGRAPHY,  FEMALE (4),
HANDWRITING,  HUMAN (4),  MENINGOENCEPHALITIS/ COMPLICATIONS,
*MENINGOENCEPHALITIS/ ETIOLOGY,  PARKINSONISM/ CEREBROSPINAL FLUID,
PARKINSONISM/ COMPLICATIONS,  *PARKINSONISM/ DRUG EFFECTS,
*PHENYLACETATES/ CEREBROSPINAL FLUID


CHALLAS G, CHAPEL JL, JENKINS RL
TOURETTE'S DISEASE: CONTROL OF SYMPTOMS AND ITS CLINICAL COURSE.
INT J NEUROPSYCHIAT 3:SUPPL 1:95-109, AUG 67
ADOLESCENCE,  CHILD,  CHILD, PRESCHOOL,  FEMALE (4),  *GILLES DE LA
TOURETTE'S DISEASE/ DRUG EFFECTS,  *HALOPERIDOL/ THERAPEUTIC USE,
HANDWRITING,  HUMAN (4),  MALE (4),  MOVEMENT DISORDERS/ DRUG
EFFECTS


COLUCCI D'AMATO F
(THERAPEUTIC ACTION OF GAMMA-AMINO-BETA-HYDROXYBUTYRIC ACID (GABOB)
ON CHOREA MINOR AND MODIFICATIONS IN GLANZMANN'S WRITING TEST
DURING THE TREATMENT)                                           (IT)
OSPED PSICHIAT 33:122-31, JAN-JUN 65
ADOLESCENCE,  CHILD,  *CHOREA/ DRUG THERAPY,  FEMALE (4),
*HANDWRITING,  HUMAN (4),  *HYDROXYBUTYRATES/ THERAPEUTIC USE,
MALE (4)


DOWNING RW, EBERT JN, BORUCHOW JK
TEMPORAL CHANGES IN HANDWRITING SIZE, LEVEL OF PREMORBID SOCIAL
FUNCTIONING AND INTELLECTURAL LEVEL DURING TREATMENT IN ACUTE
SCHIZOPHRENICS.
J NERV MENT DIS 142:526-33, JUN 66
ADOLESCENCE,  ADULT,  *CHLORPROMAZINE/ THERAPEUTIC USE,
*FLUPHENAZINE/ THERAPEUTIC USE,  *HANDWRITING,  HUMAN (4),  MIDDLE
AGE,  PSYCHOLOGICAL TESTS,  *SCHIZOPHRENIA/ DRUG THERAPY,
*SCHIZOPHRENIC PSYCHOLOGY,  *TRANQUILIZING AGENTS/ THERAPEUTIC USE
```

FIGURE 3.—*Demand Bibliographies.*



```
                                                                                  195
        ANATOMY * HISTOLOGY                               0          1          1
        DRUG EFFECTS                                      1          0          1
        EMBRYOLOGY                                        1          0          1
        METABOLISM                                        1          1          2
        PHYSIOLOGY                                        5          0          5
        SURGERY                                           1          0          1
MESENCHYMOMA                                              2          0          2
        DIAGNOSIS                                         1          0          1
        DRUG THERAPY                                      2          0          2
MESENTERIC ARTERIES                                       2          2          4
        DRUG EFFECTS                                      2          0          2
        PHYSIOLOGY                                        1          0          1
        PHYSIOPATHOLOGY                                   1          0          1
        RADIOGRAPHY                                       1          1          2
        SURGERY                                           2          0          2
MESENTERIC CYST
        DIAGNOSIS                                         1          0          1
        PATHOLOGY                                         0          1          1
        SURGERY                                           0          1          1
MESENTERIC VASCULAR OCCLUSION
        COMPLICATIONS                                     1          0          1
        RADIOGRAPHY                                       1          0          1
MESENTERIC VEINS
        DRUG EFFECTS                                      1          0          1
MESENTERY                                                 2          4          6
        ANATOMY * HISTOLOGY                               1          0          1
        CYTOLOGY                                          1          1          2
        MICROBIOLOGY                                      0          1          1
        PATHOLOGY                                         0          2          2
MESOCOLON
        ANATOMY * HISTOLOGY                               1          0          1
MESODERM                                                  0          1          1
        DRUG EFFECTS                                      1          0          1
        ENZYMOLOGY                                        1          0          1
        GROWTH * DEVELOPMENT                              1          0          1
        PHYSIOLOGY                                        1          0          1
        TRANSPLANTATION                                   1          0          1
MESONEPHROMA                                              0          1          1
        DRUG THERAPY                                      1          0          1
MESOTHELIOMA                                              1          0          1
        DIAGNOSIS                                         2          2          4
        DRUG THERAPY                                      1          0          1
MESTRANOL                                                 0          1          1
        ADMINISTRATION * DOSAGE                           1          0          1
        ADVERSE EFFECTS                                   2          0          2
        PHARMACODYNAMICS                                  5          0          5
        THERAPEUTIC USE                                   1          0          1
METABOLIC DISEASES                                        2          0          2
        DIAGNOSIS                                         2          1          3
        ETIOLOGY                                          0          1          1
```

FIGURE 4.—*MeSH Statistical Report.*

cessing, and a satellite Honeywell-200 computer used for the slower input/output operations.

MEDLARS publications are prepared for printing by the Photon-900 Computer Phototypesetter referred to by Library staff as GRACE (GRaphic Arts Composing Equipment). GRACE is an off-line photocomposer that prints from a font of 226 characters onto nine-inch-wide positive photographic film or paper. It operates at a speed of 1.7 lines or approximately 300 characters per second. The character set includes a 6-point font, regular and boldface, upper- and lowercase, with a large subset of special characters, including diacritical marks for foreign languages; a 10-point font, uppercase, boldface; and a 14-point font, uppercase, bold.

Although the MEDLARS equipment has performed well, continued technological advances in the computer field, coupled with workloads approaching machine capacity, have required the Library staff to begin a feasibility study for a new configuration of equipment and related programs.

Staff

As of January 1, 1968, approximately 90 people were required to operate and manage MEDLARS*. Figure 6 shows how this staff was organized, along with the number of professional and non-professional personnel in each section.

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*This does not include the staff of the Cataloging Section, Technical Services Division (15 professional, 10 clerical). See Chapter VIII on the *Current Catalog.*

MEDLARS SYSTEM OVERALL DATA FLOW CHART

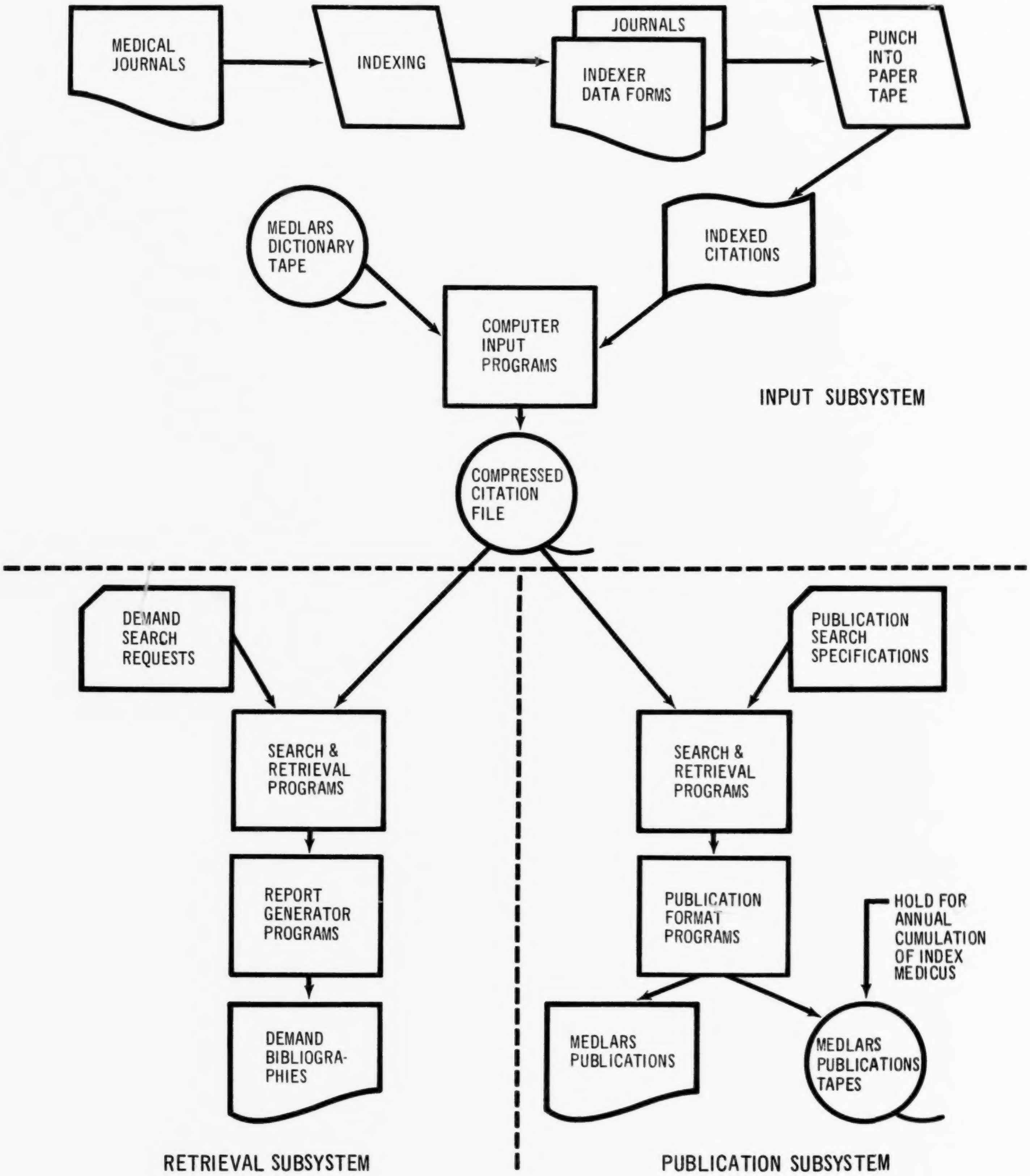
MEDICAL JOURNALS
INDEXING
JOURNALS
INDEXER DATA FORMS
PUNCH INTO PAPER TAPE
INDEXED CITATIONS
MEDLARS DICTIONARY TAPE
COMPUTER INPUT PROGRAMS
INPUT SUBSYSTEM
COMPRESSED CITATION FILE
DEMAND SEARCH REQUESTS
PUBLICATION SEARCH SPECIFICATIONS
SEARCH & RETRIEVAL PROGRAMS
SEARCH & RETRIEVAL PROGRAMS
REPORT GENERATOR PROGRAMS
PUBLICATION FORMAT PROGRAMS
HOLD FOR ANNUAL CUMULATION OF INDEX MEDICUS
DEMAND BIBLIOGRAPHIES
MEDLARS PUBLICATIONS
MEDLARS PUBLICATIONS TAPES
RETRIEVAL SUBSYSTEM
PUBLICATION SUBSYSTEM

FIGURE 5.

TABLE 2.—MEDLARS Data Processing Equipment

Qty	Manufacturer	Description
INPUT EQUIPMENT		
15	Friden, Inc.	Flexowriters (punched-paper-tape typewriters)
3	IBM	024 Card Key Punches
1	"	026 " " Punch
2	"	056 " Verifiers
1	"	557 Interpreter
1	"	082 Card Sorting Machine
1	Diebold, Inc.	Card Tub File used for pre-punched demand search input cards
COMPUTER EQUIPMENT		
1	Honeywell, Inc.	H-800 Computer with: —Central Processor —Magnetic Tape Control & Tape Switch Unit —¾" Tape Transports (7) —8,192 48-bit Word Memory Module
1	Honeywell, Inc.	H-200 Computer with: —Central Processor —Magnetic Tape Control Unit —½" Tape Transports (2) —8,192 6-bit Character Memory Module —900 line-per-minute Printer and Control —Paper Tape Reader and Control Unit —Card Reader/Punch and Control Unit —On-Line Adapter for memory-to-memory connection with H-800
OUTPUT EQUIPMENT		
1	Photon	"900"—Computer Phototypesetter (magnetic-tape-driven)
1	Eastman-Kodak	Versamat Automatic Film Processor

The Bibliographic Services Division includes trained literature analysts who index new journal articles and formulate demand searches for the computer, as well as the Medical Subject Headings staff responsible for maintaining and updating the master vocabulary of terms on which the entire system is based. The Office of Computer and Engineering Services* is responsible for computer programming and program maintenance, operation of data processing equipment, and systems analysis and design.

The personnel described in Figure 6 are only those directly involved in operation of MEDLARS. There are many other groups in the Library which perform important related activities, such as selection and acquisition of books and journals, administrative services, and research and development.

Those readers who are not interested in a detailed description of how MEDLARS operates may omit the next four chapters and turn directly to Chapter VII, Operating Experience: 1963–1967.

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*Called Data Processing Division to September 1965; Information Systems Division to January 1968.

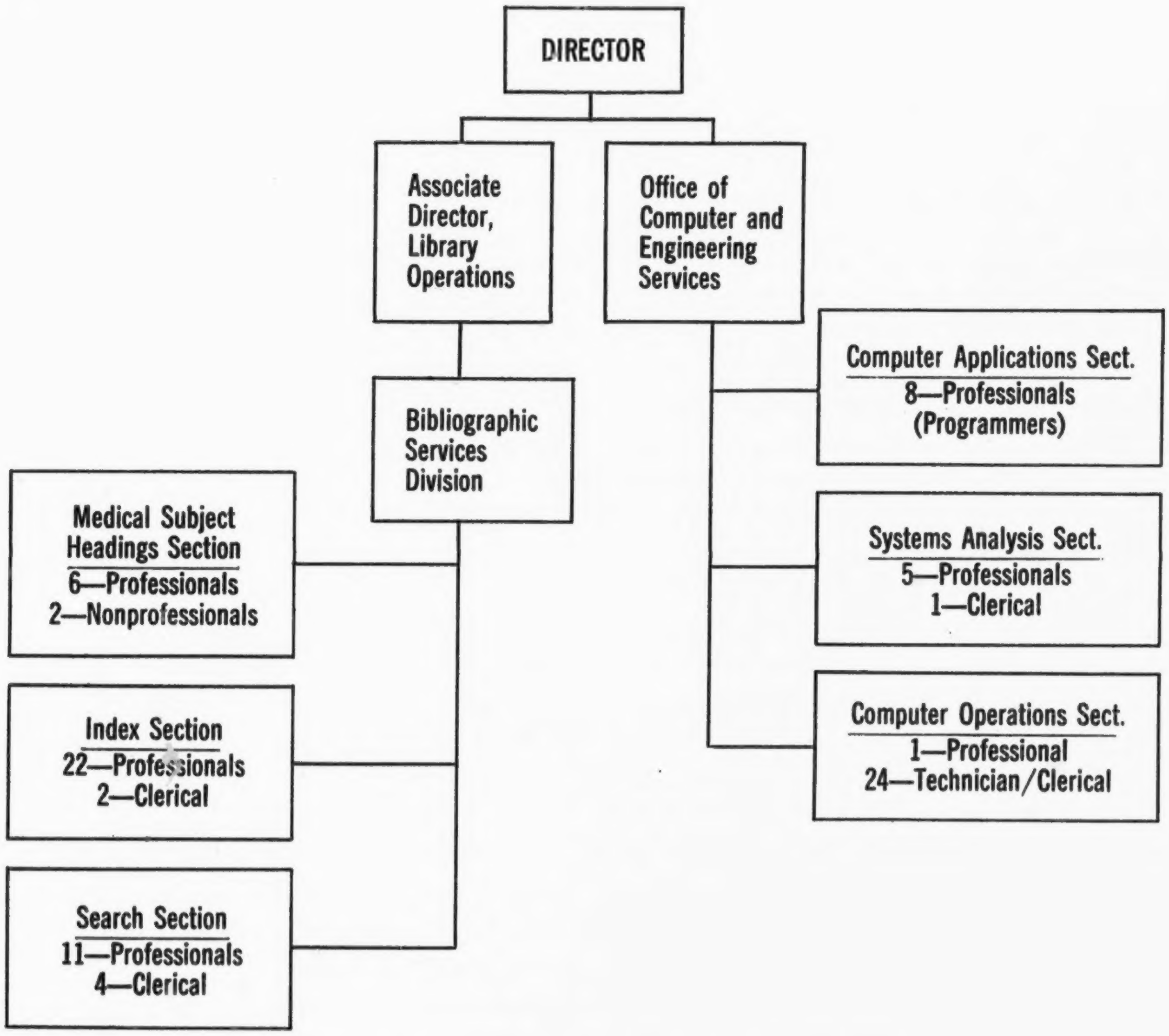

DIRECTOR
Associate Director, Library Operations
Office of Computer and Engineering Services
Bibliographic Services Division
Medical Subject Headings Section
6—Professionals
2—Nonprofessionals
Index Section
22—Professionals
2—Clerical
Search Section
11—Professionals
4—Clerical
Computer Applications Sect.
8—Professionals (Programmers)
Systems Analysis Sect.
5—Professionals
1—Clerical
Computer Operations Sect.
1—Professional
24—Technician/Clerical

FIGURE 6.—*NLM Staff Working on MEDLARS.*

Chapter III

INPUT SUBSYSTEM

The Input Subsystem is the functional portion of MEDLARS concerned with selection of journal articles, indexing, conversion to machine-readable form, and input to the computer for storage on magnetic tape.

Coverage and Selection of Journals

The National Library of Medicine currently receives between 18,000 and 19,000 different serial publications of all types, ranging from serious scientific journals to newsletters and popular works. The contents of approximately 2,300 biomedical journals are indexed for input into MEDLARS from the total number of serial publications received.

Selecting journals to be indexed is very difficult. The Library is aided in this task by the Committee on Selection of Literature for MEDLARS—an external advisory group of experts representing various medical specialties, medical librarians, and medical editors. The criteria for selecting journals for MEDLARS include: (1) coverage of a cross section of the various disciplines in the health sciences; (2) selection of the higher-quality journals; and (3) coverage of a cross section of foreign publications.

Journals selected are divided into two groups based upon the scientific significance of the material published; a depth-indexing group (journals that regularly carry reports of greater significance) and a non-depth group (journals containing material of lesser significance). The depth journals are indexed in much more detail than the non-depth, as discussed below. From the total collection of journals selected for MEDLARS, approximately 55% of the articles are in English; 45% are written in over thirty foreign languages.

Figures 7 and 7a illustrate the flow of materials through the MEDLARS Input Subsystem.

Journals received by the Library are forwarded to the Selection/Acquisition Section of the Technical Services Division. The MEDLARS journals are matched against a separate MEDLARS Serial Record. After serial checking, the cover is rubber-stamped and the MEDLARS Journal Title Code is copied from the Serial Record onto the cover of the journal, along with the volume and issue number (see Figure 8). The MEDLARS journals are batched and forwarded to the Index Section, Bibliographic Services Division, several times each day.

Medical Subject Headings

Before continuing with a description of the information flow through the Input Subsystem, it is important to describe the controlled vocabulary on which the entire system is based—the master file of Medical Subject Headings (MeSH). This section of Chapter III will describe the structure of MeSH. Procedures for maintaining and updating the master MeSH file are covered in Chapter VI.

MeSH is a controlled, yet dynamic, list of approximately 7,200 subject headings, each defined to represent a specific concept in the biomedical field. In addition to the main headings described above, the MeSH file also contains some 250 geographical headings (place names); some 500 provisional headings—new terms being considered for inclusion as main headings; and 60 subheadings used in connection with main headings at the indexer's option. In the example KIDNEY NEOPLASMS—Surgery, the first term, KIDNEY NEOPLASMS, is the main subject heading; "Surgery" is a subheading.

MEDLARS INPUT SUBSYSTEM FLOW CHART

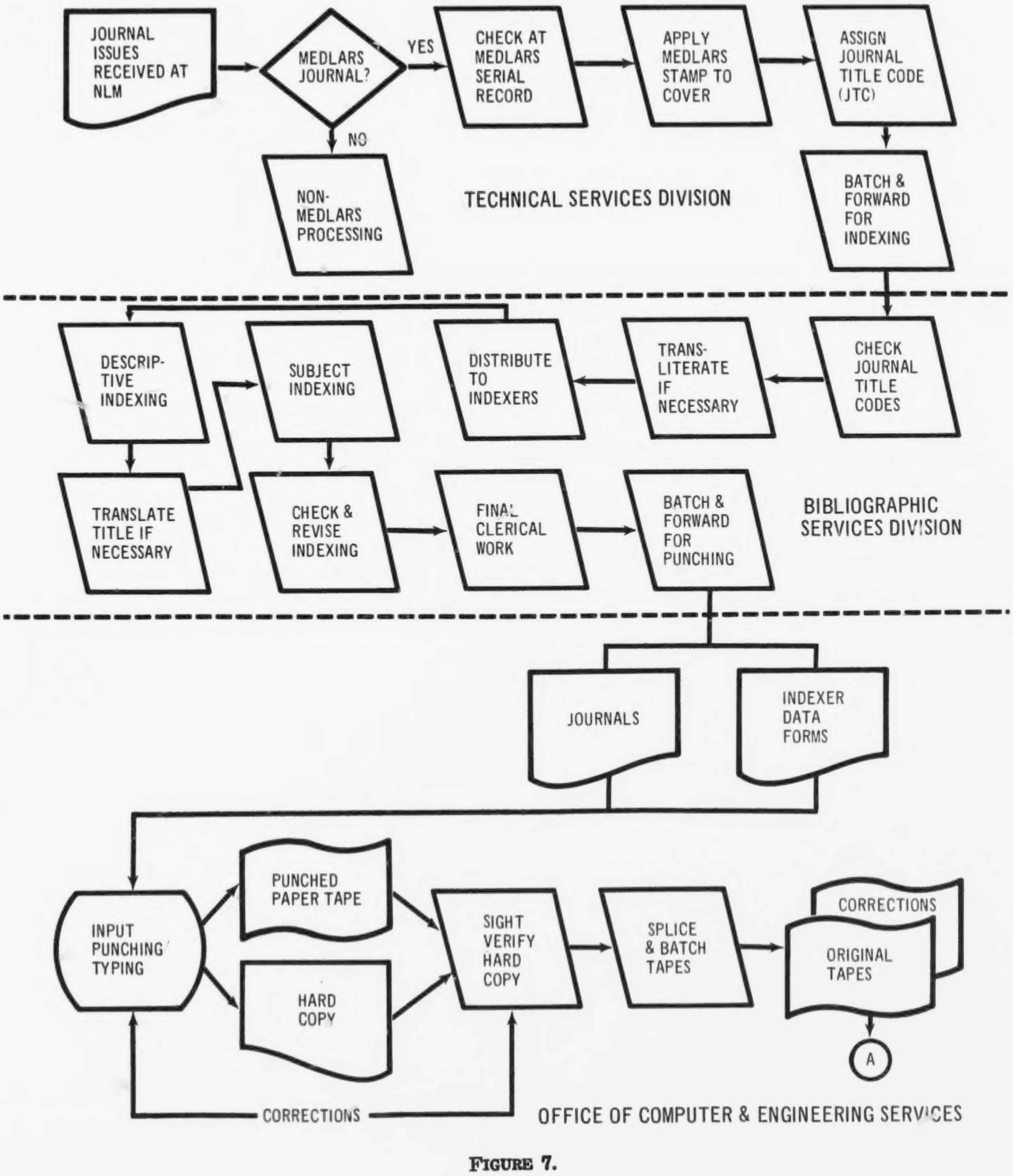
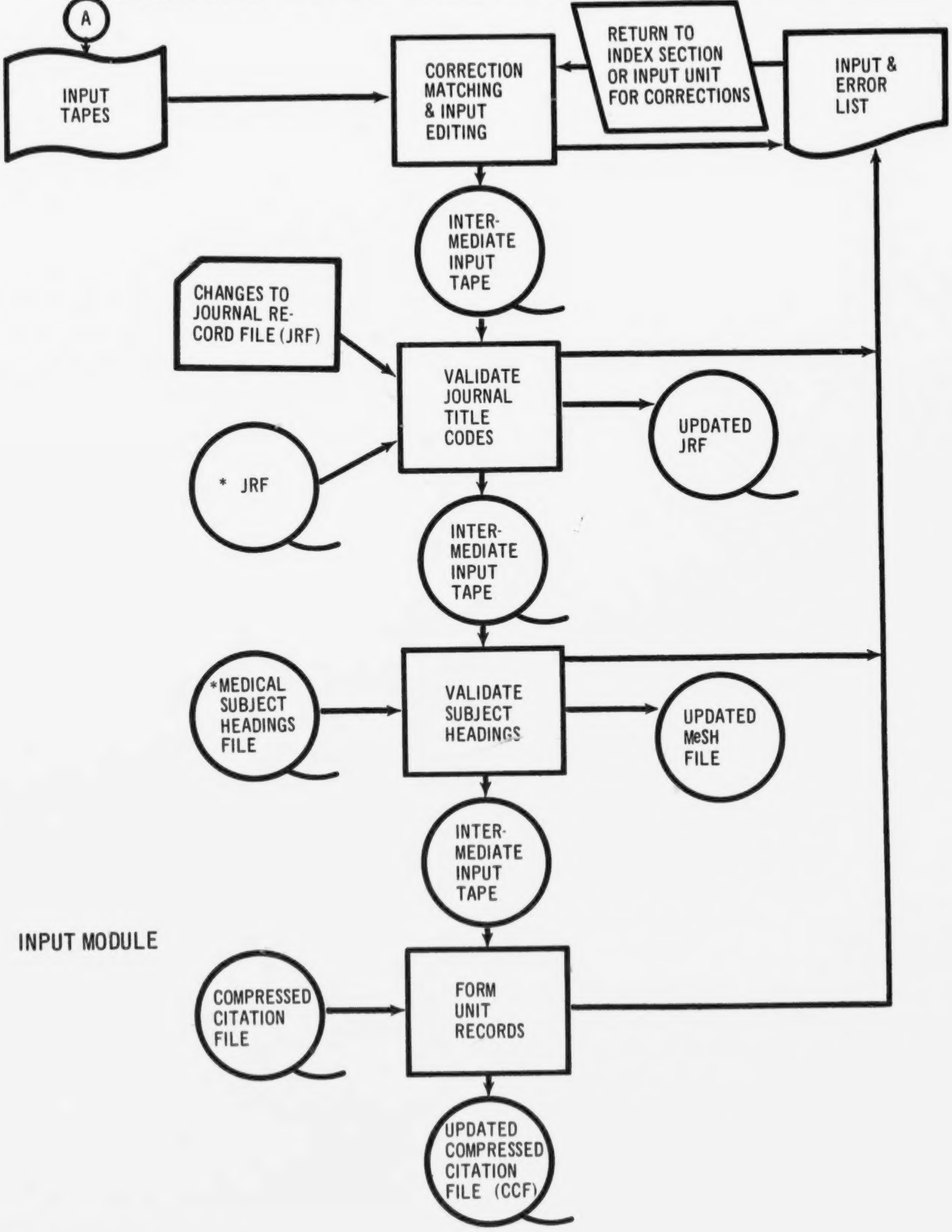

JOURNAL ISSUES RECEIVED AT NLM
MEDLARS JOURNAL?
YES
NO
CHECK AT MEDLARS SERIAL RECORD
APPLY MEDLARS STAMP TO COVER
ASSIGN JOURNAL TITLE CODE (JTC)
NON-MEDLARS PROCESSING
TECHNICAL SERVICES DIVISION
BATCH & FORWARD FOR INDEXING
DESCRIPTIVE INDEXING
SUBJECT INDEXING
DISTRIBUTE TO INDEXERS
TRANSLITERATE IF NECESSARY
CHECK JOURNAL TITLE CODES
TRANSLATE TITLE IF NECESSARY
CHECK & REVISE INDEXING
FINAL CLERICAL WORK
BATCH & FORWARD FOR PUNCHING
BIBLIOGRAPHIC SERVICES DIVISION
JOURNALS
INDEXER DATA FORMS
INPUT PUNCHING/ TYPING
PUNCHED PAPER TAPE
HARD COPY
SIGHT VERIFY HARD COPY
SPLICE & BATCH TAPES
CORRECTIONS
ORIGINAL TAPES
A
CORRECTIONS
OFFICE OF COMPUTER & ENGINEERING SERVICES

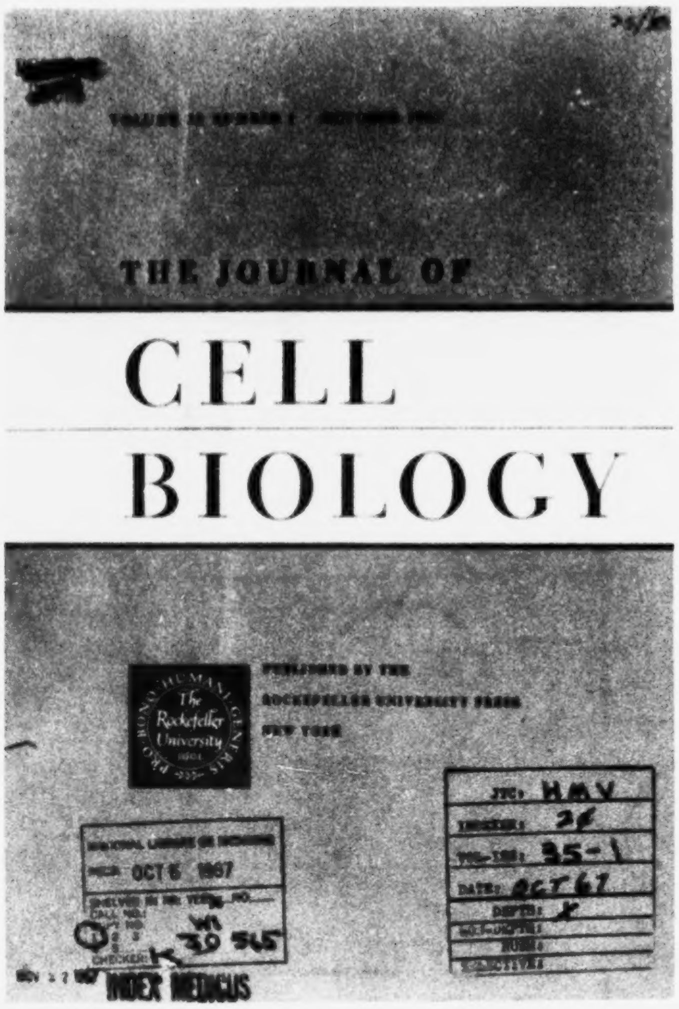
FIGURE 7.

MEDLARS INPUT SUBSYSTEM FLOW CHART


A
INPUT TAPES
CORRECTION MATCHING & INPUT EDITING
RETURN TO INDEX SECTION OR INPUT UNIT FOR CORRECTIONS
INPUT & ERROR LIST
INTER-MEDIATE INPUT TAPE
CHANGES TO JOURNAL RECORD FILE (JRF)
VALIDATE JOURNAL TITLE CODES
UPDATED JRF
* JRF
INTER-MEDIATE INPUT TAPE
*MEDICAL SUBJECT HEADINGS FILE
VALIDATE SUBJECT HEADINGS
UPDATED MeSH FILE
INTER-MEDIATE INPUT TAPE
INPUT MODULE
COMPRESSED CITATION FILE
FORM UNIT RECORDS
UPDATED COMPRESSED CITATION FILE (CCF)

*These files are found on the Medlars Dictionary Tape.

FIGURE 7a.


THE JOURNAL OF

CELL
BIOLOGY

OCT 5 1967

JTC: HMV

INDEXER: 26

VOL-ISS: 35-1

DATE: OCT 67

INDEX MEDICUS

FIGURE 8.—*Stamped MEDLARS Journal.*

MeSH is published once a year in an alphabetic and categorized arrangement (see Figure 9). In addition to this published version, several computer listings are printed each year for use internally by indexers and search specialists at NLM.

Keeping MeSH current with new concepts and terminology in medicine is a demanding task. The professional staff members charged with keeping MeSH up-to-date have received assistance from outside experts in various medical specialties. Although outside assistance has been helpful, a recently completed MEDLARS evaluation (described in Chapter VII) has shown that more reliance on actual term usage in the literature and in search requests, with less reliance on committees of experts, will help to further improve the vocabulary.

In addition to the alphabetic terms, MeSH has also been structured into a hierarchical classification, or "tree structure," to facilitate search and retrieval. A sample page from the tree structure is shown in Figure 10.

MeSH is not a new vocabulary; rather, it has been developed over the years with the printed *Index Medicus* and its predecessor publications. The content of the vocabulary relates to usage of terms in the literature itself. This necessarily means that the list of terms must be dynamic and change to meet new concepts in the field of medicine. The dynamic nature of MeSH during the MEDLARS years is dramatically shown in Table 3.

Table 3

Changes in the Medical Subject Headings File

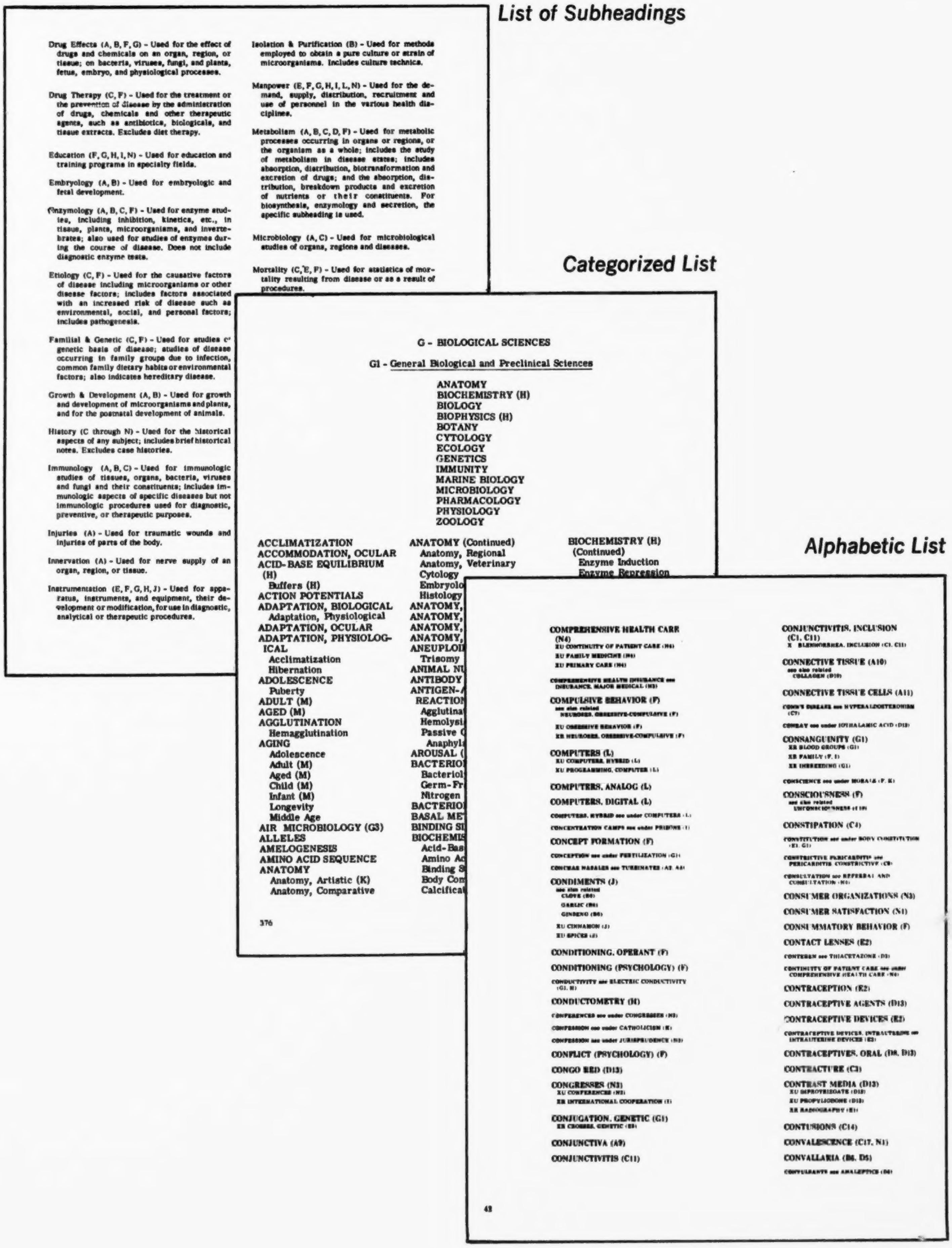
Item	1964	1965	1966	1967
Main Headings	5812	6345	6566	6800
Geographical Headings	149	144	175	264
Provisional Headings	300	612	531	434
Subheadings	0	0	42	53

Indexing and Revision

Journals received from the Selection/Acquisition Section (see flow chart, Figure 7) are given first to a highly trained clerk in the Index Section, who verifies the Journal Title Code and transliterates the title and names of authors for all journals printed in Cyrillic alphabets. This clerk also separates the journals into categories: those to be indexed in depth, the non-depth journals, those to be handled on a "rush" basis for processing, and those to be selectively indexed for medically related papers only. The journal issues then are distributed to the professional indexers, taking into consideration the special subject or foreign-language skills of each individual.

The indexers prepare an Indexer Data Form (see Figure 11) for each article in the journal. Most journals are indexed cover-to-cover for all substantive articles. These may on occasion include, in addition to original articles, letters, editorials, biographies, and obituaries. A few journals, such as *Science* and *Nature*, are indexed selectively only for articles in the field of medicine.

The indexer first scans and evaluates the article to find out what it is about and what


List of Subheadings
Categorized List
Alphabetic List

Drug Effects (A, B, F, G) - Used for the effect of drugs and chemicals on an organ, region, or tissue; on bacteria, viruses, fungi, and plants, fetus, embryo, and physiological processes.

Drug Therapy (C, F) - Used for the treatment or the prevention of disease by the administration of drugs, chemicals and other therapeutic agents, such as antibiotics, biologicals, and tissue extracts. Excludes diet therapy.

Education (F, G, H, I, N) - Used for education and training programs in specialty fields.

Embryology (A, B) - Used for embryologic and fetal development.

Enzymology (A, B, C, F) - Used for enzyme studies, including inhibition, kinetics, etc., in tissue, plants, microorganisms, and invertebrates; also used for studies of enzymes during the course of disease. Does not include diagnostic enzyme tests.

Etiology (C, F) - Used for the causative factors of disease including microorganisms or other disease factors; includes factors associated with an increased risk of disease such as environmental, social, and personal factors; includes pathogenesis.

Familial & Genetic (C, F) - Used for studies c' genetic basis of disease; studies of disease occurring in family groups due to infection, common family dietary habits or environmental factors; also indicates hereditary disease.

Growth & Development (A, B) - Used for growth and development of microorganisms and plants, and for the postnatal development of animals.

History (C through N) - Used for the historical aspects of any subject; includes brief historical notes. Excludes case histories.

Immunology (A, B, C) - Used for immunologic studies of tissues, organs, bacteria, viruses and fungi and their constituents; includes immunologic aspects of specific diseases but not immunologic procedures used for diagnostic, preventive, or therapeutic purposes.

Injuries (A) - Used for traumatic wounds and injuries of parts of the body.

Innervation (A) - Used for nerve supply of an organ, region, or tissue.

Instrumentation (E, F, G, H, J) - Used for apparatus, instruments, and equipment, their development or modification, for use in diagnostic, analytical or therapeutic procedures.

Isolation & Purification (B) - Used for methods employed to obtain a pure culture or strain of microorganisms. Includes culture technics.

Manpower (E, F, G, H, I, L, N) - Used for the demand, supply, distribution, recruitment and use of personnel in the various health disciplines.

Metabolism (A, B, C, D, F) - Used for metabolic processes occurring in organs or regions, or the organism as a whole; includes the study of metabolism in disease states; includes absorption, distribution, biotransformation and excretion of drugs; and the absorption, distribution, breakdown products and excretion of nutrients or their constituents. For biosynthesis, enzymology and secretion, the specific subheading is used.

Microbiology (A, C) - Used for microbiological studies of organs, regions and diseases.

Mortality (C, E, F) - Used for statistics of mortality resulting from disease or as a result of procedures.

G - BIOLOGICAL SCIENCES

G1 - General Biological and Preclinical Sciences

ANATOMY
BIOCHEMISTRY (H)
BIOLOGY
BIOPHYSICS (H)
BOTANY
CYTOLOGY
ECOLOGY
GENETICS
IMMUNITY
MARINE BIOLOGY
MICROBIOLOGY
PHARMACOLOGY
PHYSIOLOGY
ZOOLOGY

ACCLIMATIZATION
ACCOMMODATION, OCULAR
ACID-BASE EQUILIBRIUM (H)
  Buffers (H)
ACTION POTENTIALS
ADAPTATION, BIOLOGICAL
  Adaptation, Physiological
ADAPTATION, OCULAR
ADAPTATION, PHYSIOLOGICAL
  Acclimatization
  Hibernation
ADOLESCENCE
  Puberty
ADULT (M)
AGED (M)
AGGLUTINATION
  Hemagglutination
AGING
  Adolescence
  Adult (M)
  Aged (M)
  Child (M)
  Infant (M)
  Longevity
  Middle Age
AIR MICROBIOLOGY (G3)
ALLELES
AMELOGENESIS
AMINO ACID SEQUENCE
ANATOMY
  Anatomy, Artistic (K)
  Anatomy, Comparative

ANATOMY (Continued)
  Anatomy, Regional
  Anatomy, Veterinary
  Cytology
  Embryolo
  Histology
ANATOMY,
ANATOMY,
ANATOMY,
ANATOMY,
ANEUPLOI
  Trisomy
ANIMAL NU
ANTIBODY
ANTIGEN-A
  REACTION
  Agglutina
  Hemolysi
  Passive C
    Anaphyla
AROUSAL (
BACTERIO
  Bacteriol
  Germ-Fr
  Nitrogen
BACTERIO
BASAL ME
BINDING SI
BIOCHEMIS
  Acid-Bas
  Amino Ac
  Binding S
  Body Com
  Calcificat

BIOCHEMISTRY (H)
 (Continued)
  Enzyme Induction
  Enzyme Repression

376

COMPREHENSIVE HEALTH CARE (N4)
  XU CONTINUITY OF PATIENT CARE (N4)
  XU FAMILY MEDICINE (N4)
  XU PRIMARY CARE (N4)

COMPREHENSIVE HEALTH INSURANCE see INSURANCE, MAJOR MEDICAL (N3)

COMPULSIVE BEHAVIOR (F)
  see also related
    NEUROSES, OBSESSIVE-COMPULSIVE (F)
  XU OBSESSIVE BEHAVIOR (F)
  XR NEUROSES, OBSESSIVE-COMPULSIVE (F)

COMPUTERS (L)
  XU COMPUTERS, HYBRID (L)
  XU PROGRAMMING, COMPUTER (L)

COMPUTERS, ANALOG (L)

COMPUTERS, DIGITAL (L)

COMPUTERS, HYBRID see under COMPUTERS (L)

CONCENTRATION CAMPS see under PRISONS (I)

CONCEPT FORMATION (F)

CONCEPTION see under FERTILIZATION (G1)

CONCHAE NASALES see TURBINATES (A2, A4)

CONDIMENTS (J)
  see also related
    CLOVE (B6)
    GARLIC (B6)
    GINSENG (B6)
  XU CINNAMON (J)
  XU SPICES (J)

CONDITIONING, OPERANT (F)

CONDITIONING (PSYCHOLOGY) (F)

CONDUCTIVITY see ELECTRIC CONDUCTIVITY (G1, H)

CONDUCTOMETRY (H)

CONFERENCES see under CONGRESSES (N3)

CONFESSION see under CATHOLICISM (K)

CONFESSION see under JURISPRUDENCE (N3)

CONFLICT (PSYCHOLOGY) (F)

CONGO RED (D12)

CONGRESSES (N3)
  XU CONFERENCES (N3)
  XR INTERNATIONAL COOPERATION (I)

CONJUGATION, GENETIC (G1)
  XR CROSSES, GENETIC (G5)

CONJUNCTIVA (A9)

CONJUNCTIVITIS (C11)

CONJUNCTIVITIS, INCLUSION (C1, C11)
  X BLENNORRHEA, INCLUSION (C1, C11)

CONNECTIVE TISSUE (A10)
  see also related
    COLLAGEN (D10)

CONNECTIVE TISSUE CELLS (A11)

CONN'S DISEASE see HYPERALDOSTERONISM (C7)

CONRAY see under IOTHALAMIC ACID (D12)

CONSANGUINITY (G1)
  XR BLOOD GROUPS (G1)
  XR FAMILY (F, I)
  XR INBREEDING (G1)

CONSCIENCE see under MORALS (F, K)

CONSCIOUSNESS (F)
  see also related
    UNCONSCIOUSNESS (C10)

CONSTIPATION (C4)

CONSTITUTION see under BODY CONSTITUTION (E1, G1)

CONSTRICTIVE PERICARDITIS see PERICARDITIS, CONSTRICTIVE (C8)

CONSULTATION see REFERRAL AND CONSULTATION (N4)

CONSUMER ORGANIZATIONS (N3)

CONSUMER SATISFACTION (N1)

CONSUMMATORY BEHAVIOR (F)

CONTACT LENSES (E2)

CONTEBEN see THIACETAZONE (D3)

CONTINUITY OF PATIENT CARE see under COMPREHENSIVE HEALTH CARE (N4)

CONTRACEPTION (E2)

CONTRACEPTIVE AGENTS (D13)

CONTRACEPTIVE DEVICES (E2)

CONTRACEPTIVE DEVICES, INTRAUTERINE see INTRAUTERINE DEVICES (E2)

CONTRACEPTIVES, ORAL (D8, D13)

CONTRACTURE (C3)

CONTRAST MEDIA (D12)
  XU DIPROTRIZOATE (D12)
  XU PROPYLIODONE (D12)
  XR RADIOGRAPHY (E1)

CONTUSIONS (C14)

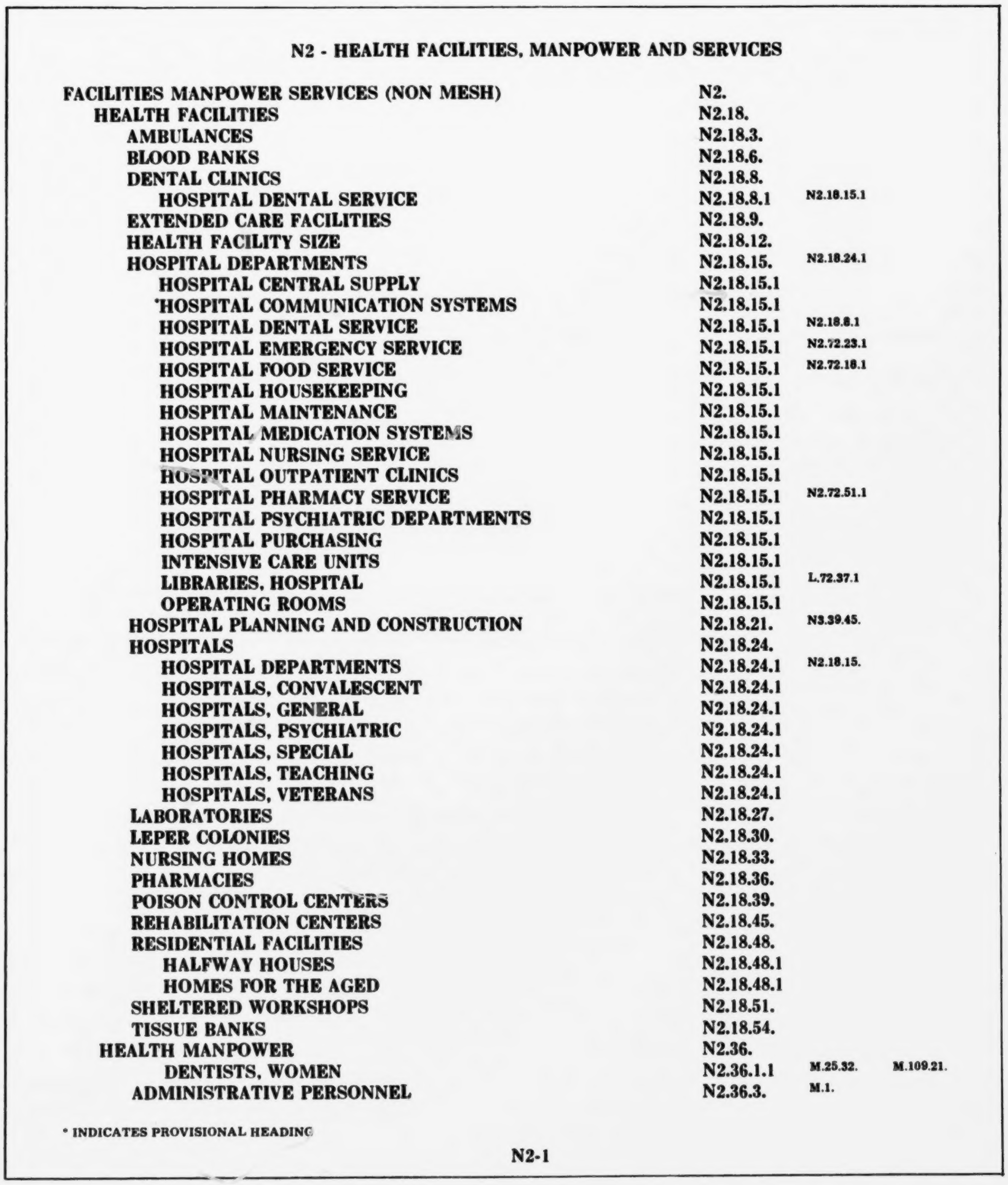
CONVALESCENCE (C17, N1)

CONVALLARIA (B6, D5)

CONVULSANTS see ANALEPTICS (D4)

42

FIGURE 9.—*Specimen MeSH Pages.*



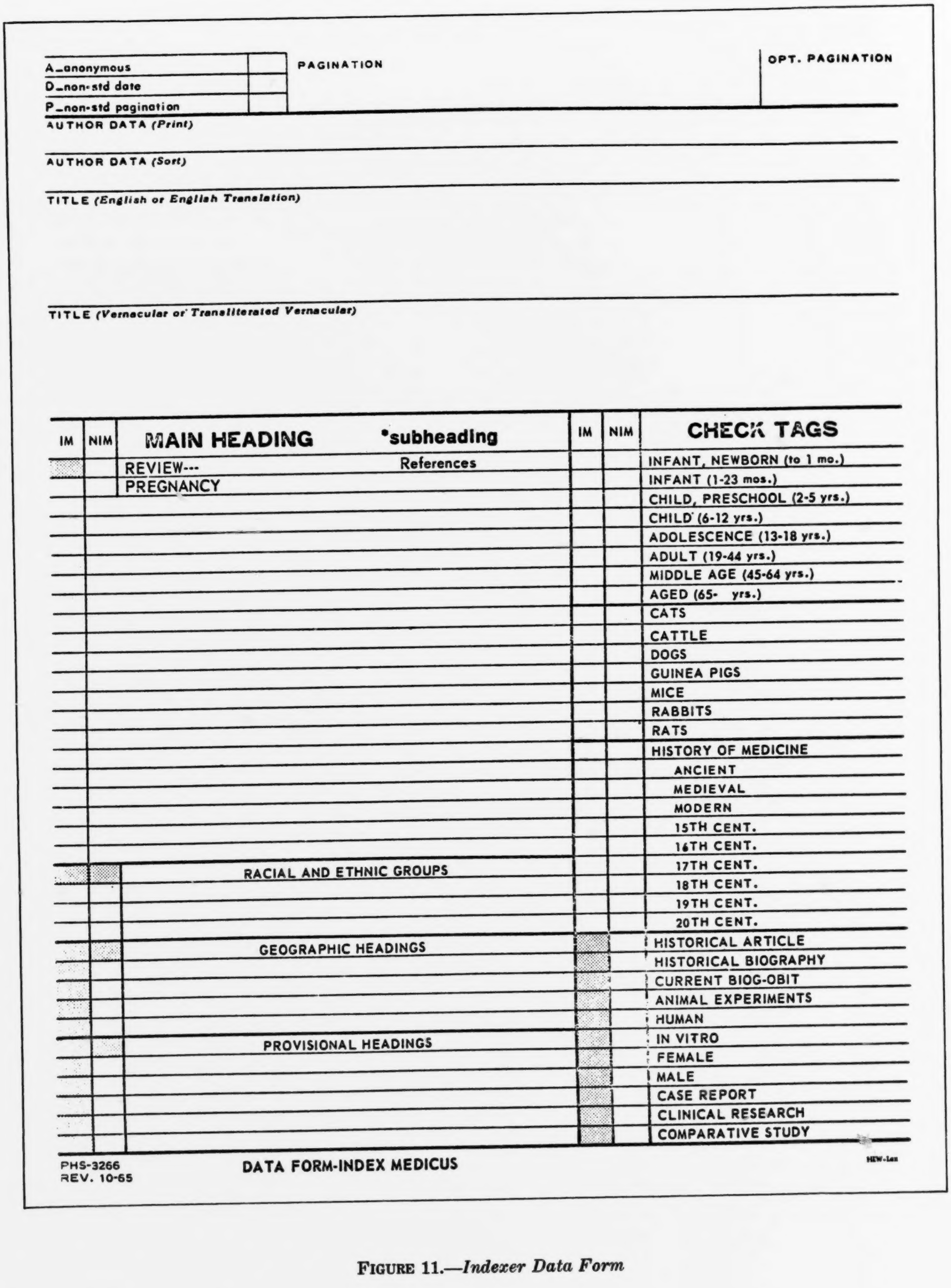
N2 - HEALTH FACILITIES, MANPOWER AND SERVICES

FACILITIES MANPOWER SERVICES (NON MESH)	N2.		
HEALTH FACILITIES	N2.18.		
AMBULANCES	N2.18.3.		
BLOOD BANKS	N2.18.6.		
DENTAL CLINICS	N2.18.8.		
HOSPITAL DENTAL SERVICE	N2.18.8.1	N2.18.15.1	
EXTENDED CARE FACILITIES	N2.18.9.		
HEALTH FACILITY SIZE	N2.18.12.		
HOSPITAL DEPARTMENTS	N2.18.15.	N2.18.24.1	
HOSPITAL CENTRAL SUPPLY	N2.18.15.1		
*HOSPITAL COMMUNICATION SYSTEMS	N2.18.15.1		
HOSPITAL DENTAL SERVICE	N2.18.15.1	N2.18.8.1	
HOSPITAL EMERGENCY SERVICE	N2.18.15.1	N2.72.23.1	
HOSPITAL FOOD SERVICE	N2.18.15.1	N2.72.18.1	
HOSPITAL HOUSEKEEPING	N2.18.15.1		
HOSPITAL MAINTENANCE	N2.18.15.1		
HOSPITAL MEDICATION SYSTEMS	N2.18.15.1		
HOSPITAL NURSING SERVICE	N2.18.15.1		
HOSPITAL OUTPATIENT CLINICS	N2.18.15.1		
HOSPITAL PHARMACY SERVICE	N2.18.15.1	N2.72.51.1	
HOSPITAL PSYCHIATRIC DEPARTMENTS	N2.18.15.1		
HOSPITAL PURCHASING	N2.18.15.1		
INTENSIVE CARE UNITS	N2.18.15.1		
LIBRARIES, HOSPITAL	N2.18.15.1	L.72.37.1	
OPERATING ROOMS	N2.18.15.1		
HOSPITAL PLANNING AND CONSTRUCTION	N2.18.21.	N3.39.45.	
HOSPITALS	N2.18.24.		
HOSPITAL DEPARTMENTS	N2.18.24.1	N2.18.15.	
HOSPITALS, CONVALESCENT	N2.18.24.1		
HOSPITALS, GENERAL	N2.18.24.1		
HOSPITALS, PSYCHIATRIC	N2.18.24.1		
HOSPITALS, SPECIAL	N2.18.24.1		
HOSPITALS, TEACHING	N2.18.24.1		
HOSPITALS, VETERANS	N2.18.24.1		
LABORATORIES	N2.18.27.		
LEPER COLONIES	N2.18.30.		
NURSING HOMES	N2.18.33.		
PHARMACIES	N2.18.36.		
POISON CONTROL CENTERS	N2.18.39.		
REHABILITATION CENTERS	N2.18.45.		
RESIDENTIAL FACILITIES	N2.18.48.		
HALFWAY HOUSES	N2.18.48.1		
HOMES FOR THE AGED	N2.18.48.1		
SHELTERED WORKSHOPS	N2.18.51.		
TISSUE BANKS	N2.18.54.		
HEALTH MANPOWER	N2.36.		
DENTISTS, WOMEN	N2.36.1.1	M.25.32.	M.109.21.
ADMINISTRATIVE PERSONNEL	N2.36.3.	M.1.	

* INDICATES PROVISIONAL HEADING

N2-1

FIGURE 10.—*Specimen Page, MeSH Tree Structure Listing.*



A_anonymous	☐
D_non-std date	☐
P_non-std pagination	☐

PAGINATION

OPT. PAGINATION

AUTHOR DATA *(Print)*

AUTHOR DATA *(Sort)*

TITLE *(English or English Translation)*

TITLE *(Vernacular or Transliterated Vernacular)*

IM	NIM	MAIN HEADING *subheading	IM	NIM	CHECK TAGS
▨		REVIEW--- References			INFANT, NEWBORN (to 1 mo.)
		PREGNANCY			INFANT (1-23 mos.)
					CHILD, PRESCHOOL (2-5 yrs.)
					CHILD (6-12 yrs.)
					ADOLESCENCE (13-18 yrs.)
					ADULT (19-44 yrs.)
					MIDDLE AGE (45-64 yrs.)
					AGED (65- yrs.)
					CATS
					CATTLE
					DOGS
					GUINEA PIGS
					MICE
					RABBITS
					RATS
					HISTORY OF MEDICINE
					ANCIENT
					MEDIEVAL
					MODERN
					15TH CENT.
					16TH CENT.
▨	▨	RACIAL AND ETHNIC GROUPS			17TH CENT.
					18TH CENT.
					19TH CENT.
					20TH CENT.
▨	▨	GEOGRAPHIC HEADINGS	▨		HISTORICAL ARTICLE
▨			▨		HISTORICAL BIOGRAPHY
▨			▨		CURRENT BIOG-OBIT
▨			▨		ANIMAL EXPERIMENTS
▨			▨		HUMAN
▨	▨	PROVISIONAL HEADINGS	▨		IN VITRO
			▨		FEMALE
			▨		MALE
			▨		CASE REPORT
			▨		CLINICAL RESEARCH
			▨		COMPARATIVE STUDY

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REV. 10-65

DATA FORM-INDEX MEDICUS

HEW-Lan

FIGURE 11.—*Indexer Data Form*

are the most important points to be covered. Subject headings and subheadings are assigned from MeSH. The Indexer Data Form includes several check tags which serve as reminders to the indexer of concepts which always are to be covered (e.g., age groups, clinical report, etc.). In handling a depth journal, the indexer may use as many subject headings as are needed to describe fully the content of the articles. When indexing a non-depth journal, the indexer is limited to subject headings that describe the primary concepts only. As of January 1968, depth journal articles were assigned an average of about 10 subject headings and non-depth journals were assigned an average of about 4. The indexer also assigns subheadings and must insure that he uses a valid main heading/subheading combination in each case that a subheading is used.

In addition to assigning MeSH terms, the indexer decides whether each term is to be "print" or "non-print"; that is, to be printed in *Index Medicus* or to be used only in the retrieval process.

Descriptive indexing by the professional indexer includes establishment of pagination, establishment of author name format (if necessary), and translation of titles of all foreign-language articles.

After indexing, the journals with data forms attached are sent to the revisers (senior professionals who check and revise the work of the indexers). All new and trainee indexers receive 100% revision; the more experienced personnel are revised on a spot check basis.

After completion of work by the professional indexers and revisers, the journals go to a final clerical work station, where "sort authors" are established. Sort authors are required in cases where the computer is not able to follow its normal collating sequence in preparing alphabetic author lists (e.g., St. Lawrence to sort as Saint Lawrence).

In addition to performing regular production indexing functions, the Index Section carries a heavy training load, both for its own new staff members and for personnel working at Decentralized MEDLARS Stations and others outside NLM.

The original MEDLARS philosophy was to perform all indexing centrally with NLM staff. However, the massive volume of work to be done, coupled with rapidly increasing backlogs, caused Library management to reconsider this policy and begin to use outside contracts for some of the indexing work. Decentralized indexing is now underway at such places as Keio University in Japan; the MEDLARS Stations at Harvard, the University of Alabama, and the University of Colorado; and in Israel, using PL 480 counterpart funds. Private contractors have also been used. This decentralized indexing has proven quite effective.

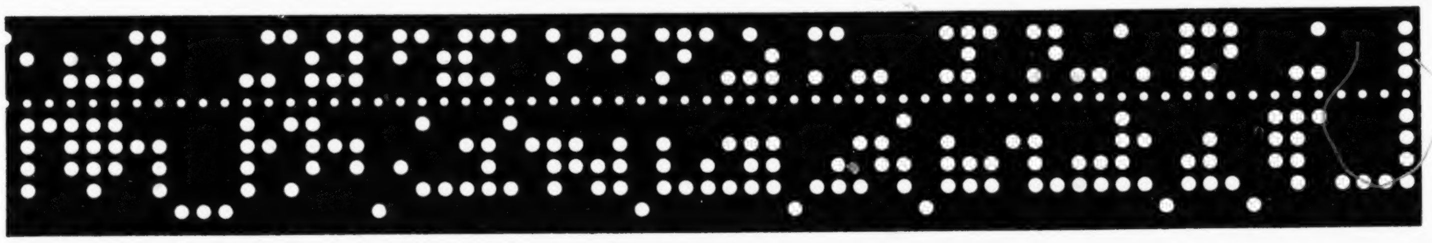
In order to insure standardization of indexing and to facilitate the training described above, a *MEDLARS Indexing Manual* was prepared. All decentralized indexing is subject to revision.

After completion of all Index Section tasks, batches of journals and data sheets are forwarded to the Office of Computer and Engineering Services for data punching and computer processing.

Input Preparation and Verification

Punched paper tape was selected as the input medium for indexed citations entering the computer system because of its versatility in handling variable-length records and its ability to input 88 different characters (an important consideration for MEDLARS publications). Punched cards and optical scanning of citations prepared by a typist (*not* scanning of the original journal article) were also considered, but, after a careful analysis, paper tape seemed to provide the best approach.

As seen from the flow chart, Figure 7, the clerk-typists in the Input Unit receive journals with Indexer Data Forms attached for initial processing. For each journal received, the typist first punches a Journal Identification Record which contains the Journal Title Code, publication date, volume and issue number, Indexer Identification Code, and Typist Identification Code. The typist then punches one tape record for each indexed article in the journal. This record includes the title of the article in the vernacular or transliterated vernacular (except for oriental articles, which include only a title translation); the



Paper Tape Strip

```
J/  7Q6       4312      225-2                          *13 Jun 66                 R/

C/            *113-22    *
A/  Korting GW, Nürnberger F,+NURNBERGER F: [Necrosis lipoidica] (Ger)
V/  Necrosis lipoidica
T/
NECROBIOSIS LIPOIDICA+PATHOLOGY
SKIN+PATHOLOGY
NECROSIS+PATHOLOGY
LEG
MIDDLE AGE
HUMAN
FEMALE
CASE REPORT
X/  R/

C/            *123-35    *
A/  Simon N, Berencsi G: [Contributions on the biological properties of Mycobacterium
tuberculosis on the basis of the sensitivity of lupus strains] (Ger)
V/  Beiträge zu den biologischen Eigenschaften auf Grund der Empfindlichkeit der Lupus-Stämme
T/
LUPUS+MICROBIOLOGY
TUBERCULOSIS, CUTANEOUS+MICROBIOLOGY
MYCOBACTERIUM TUBERCULOSIS+DRUG EFFECTS
STREPTOMYCIN+PHARMACO
ISONIAZID+PHARMACO
ISONIAZID+THERAPEUTIC USE
STREPTOMYCIN+THERAPEUTIC USE
LUPUS+DRUG THERAPY
TUBERCULOSIS, CUTANEOUS+DRUG THERAPY
DRUG RESISTANCE, MICROBIA
```

Flexowriter

Hard Copy

FIGURE 12.—*Paper Tape Strip and Flexowriter Hard Copy.*

translated title of foreign works; names of all authors or editors; the abbreviation for the language in which the article is written if it is a foreign work; the name of the subject(s) of a biography; the pagination of the article within the journal; and the descriptive tags assigned by the indexer, including main subject headings, subheadings, geographical tags, and provisional headings. Those subject headings to "print" in *Index Medicus* (headings under which the article will be cited in the published index) are punched in red-shift code and non-*Index Medicus* headings are punched in black-shift code.

The paper tape typewriters (Friden Flexowriters) operate under the control of a program tape which assists the operator in properly sequencing and identifying the data fields for the computer. The Flexowriters simultaneously produce a proof copy on continuous paper, along with the punched tape (see Figure 12).

The typist normally treats one journal issue as a batch of work for further processing, except for those journals with a very few articles, in which case several issues may be combined into one batch. The entire package (journal issue[s], Indexer Data Forms, paper tape, and Flexowriter hard copy) is then forwarded to the proofreaders.

The proofreaders sight-verify all descriptive elements of each citation on the hard copy (the subject headings are validated later during computer processing). Errors detected by the proofreaders are noted, with appropriate corrections on the hard copy, which is then returned for correction typing. The proofreaders detect one or more errors in approximately 20% of the articles punched.

Paper tape creates some problems in making corrections. Rather than attempt to correct the original tape itself by duplication or splicing, correction record(s) are punched which identify the journal article, specify the data field in error, and give the correction data. The correction record(s) are subsequently matched and applied to the original records during computer input processing.

All original input tapes and correction tapes are spliced together at the end of the day and batched for the daily input computer run. Note that correction tapes *must* be entered into the same computer run as the original data tapes to which they apply.

As of January 1, 1968, the average number of articles indexed and entered into the computer per day was approximately 700, or about 15,000 new items each month. It is obvious from these figures that MEDLARS must operate as an organized production system in order to maintain level workloads.

Input Module

Those computer programs which input the new journal articles and update the master magnetic tape file of citations are referred to as the Input Module. The Input Module consists of four major segments or submodules (see flow chart, Figure 7).

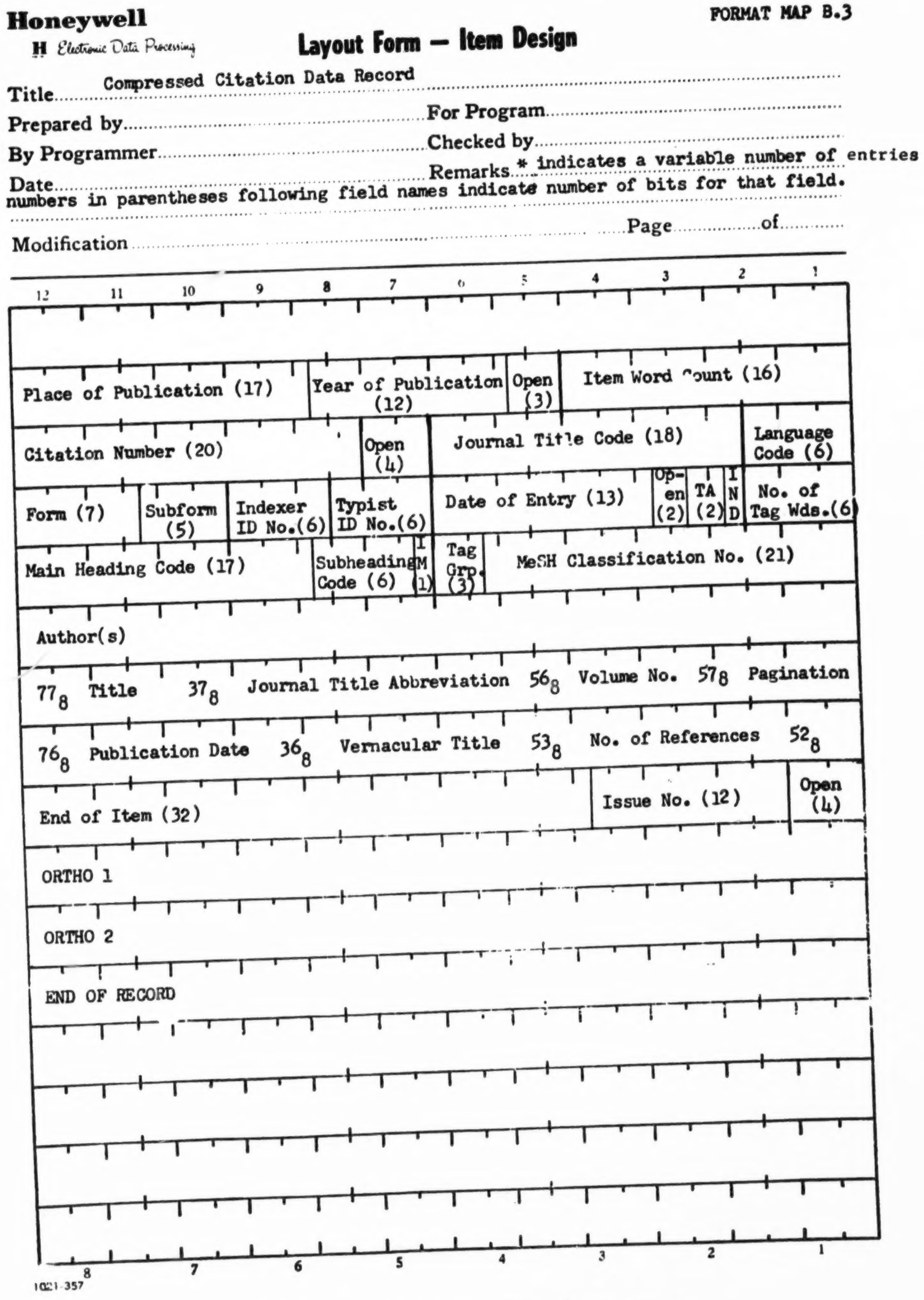
The first submodule reads in the paper tape (original and correction records), checks to see that only valid paper tape codes are present, and copies the records onto magnetic tape. The magnetic tape records are then sorted so that corrections are matched to the original typed citation. The correction data is then applied to produce a "clean" record on magnetic tape. Any errors detected by the computer (invalid codes or correction records which do not match) are printed on an error listing and these records are rejected.

FIGURE 13.—*Paper Tape Being Loaded onto Tape Reader.*

The second submodule validates the Journal Identification Record for each journal issue in the batch. The Journal Title Codes are matched to a master Journal Record File (JRF) on magnetic tape. Note that if this code is in error, all articles from that issue must be rejected and printed on the error list. The subsequent correction, retyping, and re-entry of the material into the computer is a costly process. The JRF provides the Journal Title Abbreviation which is added to the citation record at this point.

This submodule also is used for updating of the Journal Record File. Changes to the file (additions, changes, deletions) are entered via punched cards and the file is updated during input processing. The JRF also includes the full title and place of publication, which are used in printing the annual *List of Journals Indexed in Index Medicus.*

The third major submodule provides validation of all subject tags in the citations. The computer splits each citation into several



Honeywell
H Electronic Data Processing

Layout Form — Item Design

FORMAT MAP B.3

Title Compressed Citation Data Record
Prepared by
For Program
By Programmer
Checked by
Date
Remarks * indicates a variable number of entries numbers in parentheses following field names indicate number of bits for that field.
Modification
Page of

12 11 10 9 8 7 6 5 4 3 2 1

Place of Publication (17)	Year of Publication (12)	Open (3)	Item Word Count (16)					
Citation Number (20)	Open (4)	Journal Title Code (18)	Language Code (6)					
Form (7)	Subform (5)	Indexer ID No.(6)	Typist ID No.(6)	Date of Entry (13)	Op-en (2)	TA (2)	IND	No. of Tag Wds.(6)
Main Heading Code (17)	Subheading Code (6)	IM (1)	Tag Grp. (3)	MeSH Classification No. (21)				
Author(s)								
77_8 Title	37_8 Journal Title Abbreviation	56_8 Volume No.	57_8 Pagination					
76_8 Publication Date	36_8 Vernacular Title	53_8 No. of References	52_8					
End of Item (32)	Issue No. (12)	Open (4)						
ORTHO 1								
ORTHO 2								
END OF RECORD								

8 7 6 5 4 3 2 1

1021-357

FIGURE 14.—*CCF Magnetic Tape Record Layout.*

small records containing: one alphabetic subject heading and the related subheading (if any), and a Citation Identification Code. These records then are sorted into alphabetic sequence by subject heading and matched against the Master Subject Headings File on magnetic tape. Those headings which do not match the computer master file are printed on the error list and rejected; however, the citation is not rejected unless all *Index Medicus* print headings attached to it are rejected. Main heading/subheading combinations also are checked for validity.

Each time a match occurs, the master MeSH list on tape is updated by adding one to a tally of the frequency of term usage. This tally becomes important later in the Retrieval Subsystem. The alphabetic subject headings are replaced by code numbers provided by the master file. The coded subject records then are sorted back into citation number order, matched to the original citations, and complete citation records are rebuilt.

The fourth and final submodule builds the completed MEDLARS citation record on magnetic tape. The record is referred to as the MEDLARS Unit Record and the tape file itself is called the Compressed Citation File (CCF). A record layout of the data elements on the CCF is shown in Figure 14.

The CCF is a highly compact tape file which serves as the major store of information in MEDLARS, for both retrieval of individual demand bibliographies and preparation of published indexes. The file is serial, with records in sequence by computer entry date. On January 1, 1968, the CCF contained 645,751 citations on 25 reels of magnetic tape.

All errors detected by the computer editing routines are printed on an error listing which is returned to the Head of the Index Section who initiates correction action. (Note that an error could have been made by either the indexer or input typist.) Approximately 10% of the records entering the Input Module contain errors which are detected by the computer editing routines.

The various checks built into the Input Subsystems (revision of indexing, proofreading, computer edits) provide a good measure of control over the accuracy of data in the MEDLARS file. Nonetheless, some errors do get through, and these are usually picked up later when they appear in a publication or a demand search.

The Input Subsystem provides the raw material used for retrieval and publication, described in the next two chapters.

Chapter IV

RETRIEVAL SUBSYSTEM

The Retrieval Subsystem of MEDLARS is concerned with matching requests for individual bibliographies to the citations on the Compressed Citation File. This subsystem combines the search formulation talents of trained search specialists with the rapid matching and retrieval capabilities of the computer to produce demand bibliographies.

Request Analysis and Search Formulation

The demand search cycle begins with receipt of requests for MEDLARS searches from medical educators, practitioners, and researchers. The searches are requested for a variety of purposes (e.g., to determine the state of research in a particular field, to assist in the preparation of review articles, to help solve a clinical problem). Most search requests processed at NLM and the U.S. MEDLARS Stations (at UCLA, Harvard, Ohio State University, and the universities of Colorado, Alabama, and Michigan) are received from research workers and educators, with about 95% originating in the United States.

A clear, concise statement of the search request is important for effective retrieval in MEDLARS (as in any other reference or retrieval system). Requests are made on MEDLARS Search Request Forms (see Figure 15) and may be submitted through local medical libraries or directly to NLM. In order to improve search requests and optimize use of the service, a booklet has been prepared to assist users in understanding the capabilities, limitations, and conditions under which searches are accomplished.*

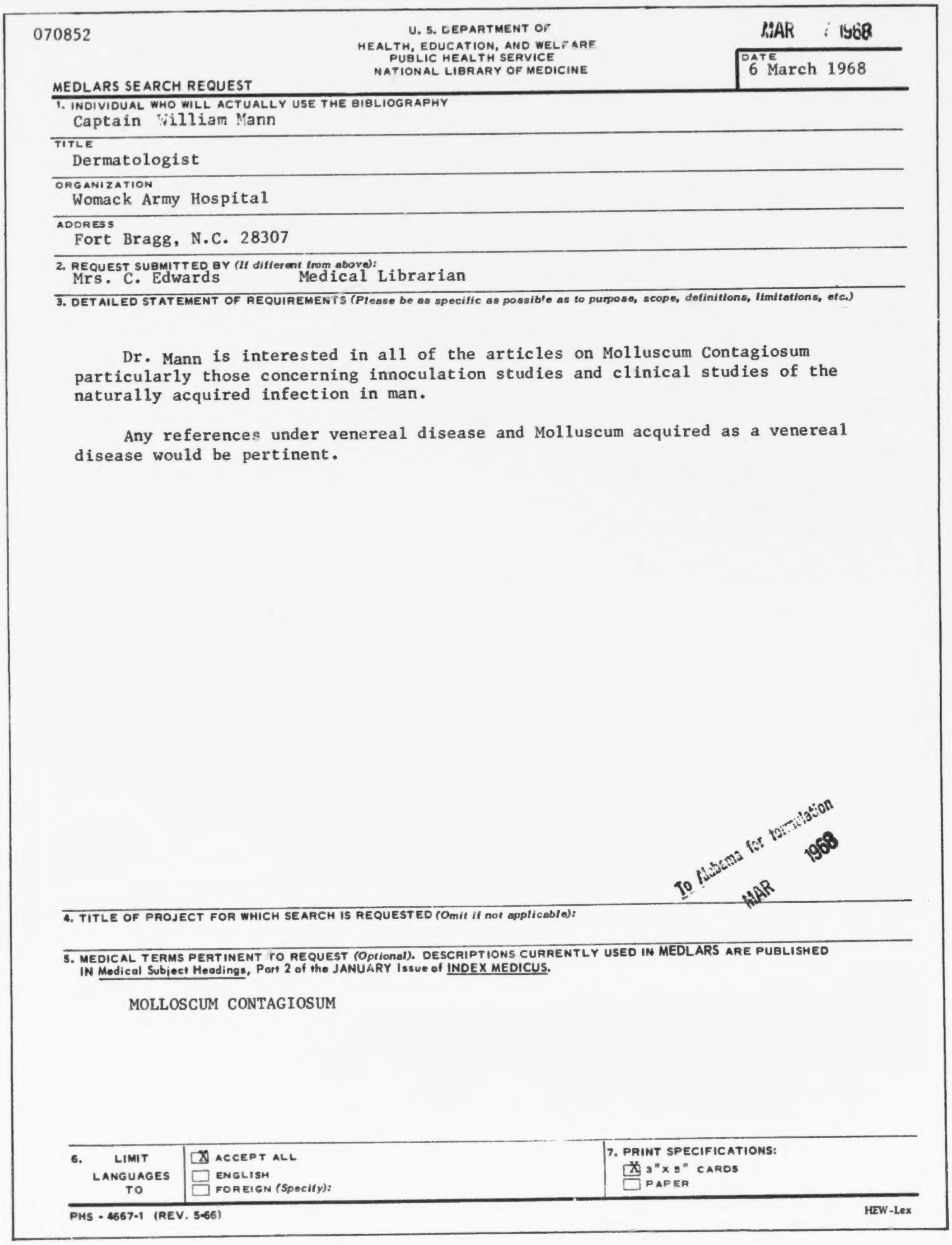
In submitting his search request, the user is asked to present a detailed, specific statement of requirements, to cite pertinent citations that he may know of, to estimate the number of citations he would expect to receive, and to state any restrictions to be placed on the search. He also indicates which languages he wishes included in the search and whether he wants his final bibliography printed on 8½″ x 11″ paper or on 3″ x 5″ cards.

The search specialist (or "searcher") is a highly trained intermediary who must interact with both the requester and the computer. This requester-searcher interaction can occur at several different levels, including: (1) request form or letter received in the mail, with no direct contact; (2) request form received in the mail after requester has had discussion and advice from his local librarian; (3) request received by telephone call; (4) request received during direct interview with the requester. Searchers are encouraged to clarify requests and make liberal use of the telephone before beginning to formulate the search.

After the searcher has analyzed and clarified the request, he begins building his search formulation, which is used as the basis for computer matching and retrieval. Figure 16 is a sample search formulation. The formulation consists of two major parts: a list of the search elements to be used, and from one to three search equations showing the logical relationship between elements in the search.

The main elements used in searching are

**A Guide to MEDLARS Services*, U.S. Dept. of Health, Education, and Welfare, Public Health Service, National Library of Medicine, Bethesda, Maryland, 1967.



070852

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL LIBRARY OF MEDICINE

MAR 7 1968

DATE
6 March 1968

MEDLARS SEARCH REQUEST

1. INDIVIDUAL WHO WILL ACTUALLY USE THE BIBLIOGRAPHY
Captain William Mann

TITLE
Dermatologist

ORGANIZATION
Womack Army Hospital

ADDRESS
Fort Bragg, N.C. 28307

2. REQUEST SUBMITTED BY *(If different from above)*:
Mrs. C. Edwards Medical Librarian

3. DETAILED STATEMENT OF REQUIREMENTS *(Please be as specific as possible as to purpose, scope, definitions, limitations, etc.)*

Dr. Mann is interested in all of the articles on Molluscum Contagiosum particularly those concerning innoculation studies and clinical studies of the naturally acquired infection in man.

Any references under venereal disease and Molluscum acquired as a venereal disease would be pertinent.

To Alabama for formulation
MAR 1968

4. TITLE OF PROJECT FOR WHICH SEARCH IS REQUESTED *(Omit if not applicable)*:

5. MEDICAL TERMS PERTINENT TO REQUEST *(Optional)*. DESCRIPTIONS CURRENTLY USED IN MEDLARS ARE PUBLISHED IN Medical Subject Headings, Part 2 of the JANUARY Issue of INDEX MEDICUS.

MOLLOSCUM CONTAGIOSUM

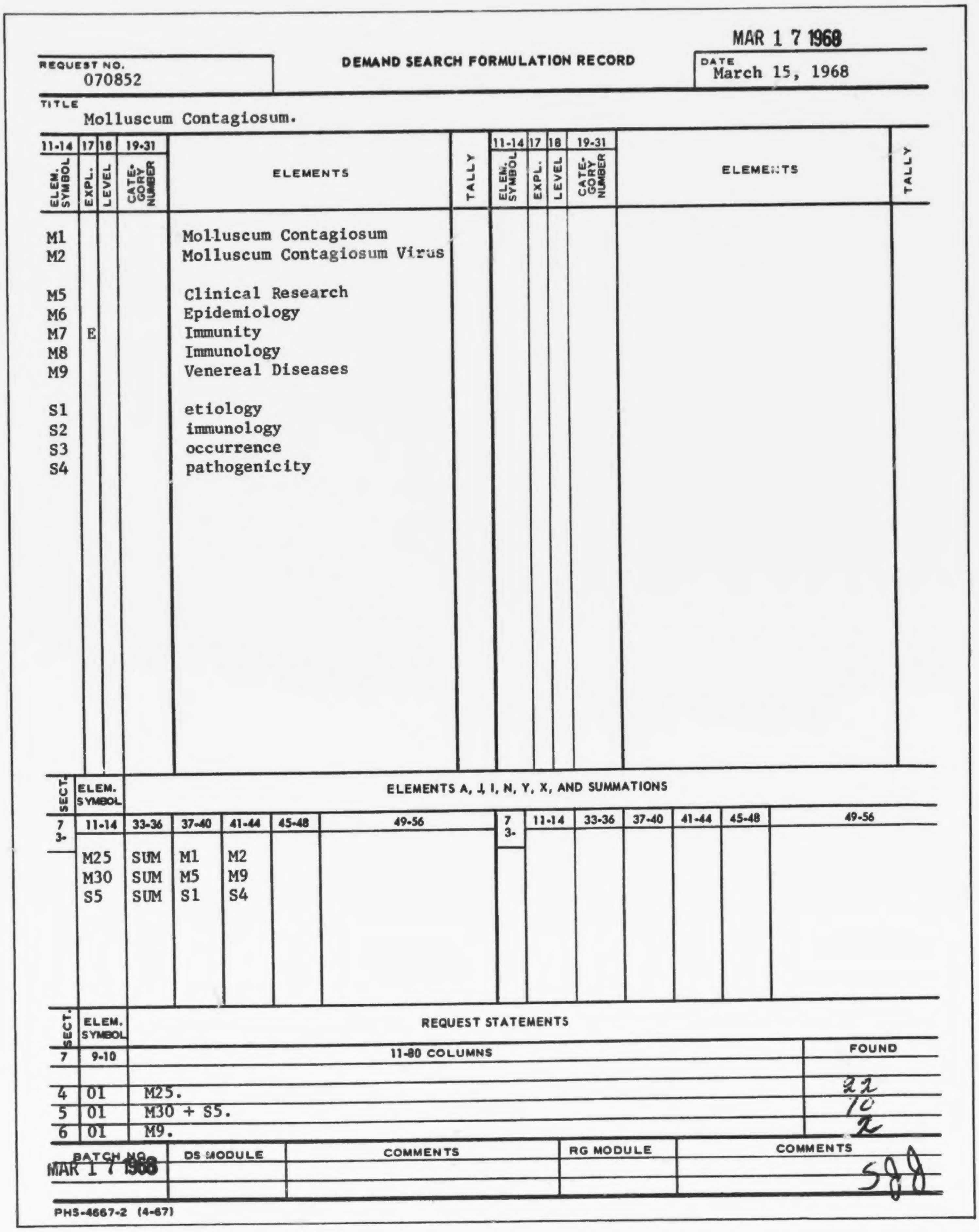
6. LIMIT LANGUAGES TO
☒ ACCEPT ALL
☐ ENGLISH
☐ FOREIGN *(Specify)*:

7. PRINT SPECIFICATIONS:
☒ 3" x 5" CARDS
☐ PAPER

PHS - 4667-1 (REV. 5-66)

HEW-Lex

FIGURE 15.—*Specimen MEDLARS Search Request.*



MAR 1 7 1968

DEMAND SEARCH FORMULATION RECORD

REQUEST NO. 070852

DATE March 15, 1968

TITLE Molluscum Contagiosum.

ELEM. SYMBOL 11-14	EXPL. 17	LEVEL 18	CATE-GORY NUMBER 19-31	ELEMENTS	TALLY	ELEM. SYMBOL 11-14	EXPL. 17	LEVEL 18	CATE-GORY NUMBER 19-31	ELEMENTS	TALLY
M1				Molluscum Contagiosum							
M2				Molluscum Contagiosum Virus							
M5				Clinical Research							
M6				Epidemiology							
M7	E			Immunity							
M8				Immunology							
M9				Venereal Diseases							
S1				etiology							
S2				immunology							
S3				occurrence							
S4				pathogenicity							

ELEMENTS A, J, I, N, Y, X, AND SUMMATIONS

SECT. 7 3-	ELEM. SYMBOL 11-14	33-36	37-40	41-44	45-48	49-56	SECT. 7 3-	11-14	33-36	37-40	41-44	45-48	49-56
	M25	SUM	M1	M2									
	M30	SUM	M5	M9									
	S5	SUM	S1	S4									

REQUEST STATEMENTS

SECT. 7	ELEM. SYMBOL 9-10	11-80 COLUMNS	FOUND
4	01	M25.	22
5	01	M30 + S5.	10
6	01	M9.	2

BATCH NO.	DS MODULE	COMMENTS	RG MODULE	COMMENTS
MAR 1 7 1968				

PHS-4667-2 (4-67)

FIGURE 16.—*Specimen Demand Search Formulation Record.*

terms from the master MeSH list. However, other search elements such as author names, journal titles, and year of publication may be used as well. Table 4 lists the search elements which can be used in MEDLARS.

Table 4
MEDLARS Search Elements

Element Symbol	Name
M	Main Heading
S	Subheading
G	Geographic Heading
F	Form Heading (e.g., Review Article)
T	Main Heading Used Only as "Print" Term for *Index Medicus*
Z	Main Heading Used as non-*Index Medicus* Term
C	Category Number from MeSH Hierarchy
A	Author Name
J	Journal Title Code
I	Computer Entry Date
L	Language Abbreviation
Q	Place of Publication
Y	Year of Publication
X	Main Heading/Subheading Combination

The number of elements used in any given search varies. The searcher also may "explode" a subject heading by using the symbol "E" after the term and designating the number of levels in the MeSH hierarchy to which the term is to be expanded. The computer will then search not only for the stated term, but also for other terms specific to it in the hierarchy. In addition to the MeSH tree structure, the searchers have developed informal collections of headings which often are useful in search formulation as "horizontal" patterns of relationships (referred to as "hedges"). These hedges cut across the several MeSH categories and allow grouping together a collection of terms which identify a concept required in the search. Trees and hedges are an important feature of MEDLARS search formulation.

Groups of terms are frequently used together in search formulation. These can be referred to logically in the fomulation record by use of the "sum" element. For example:

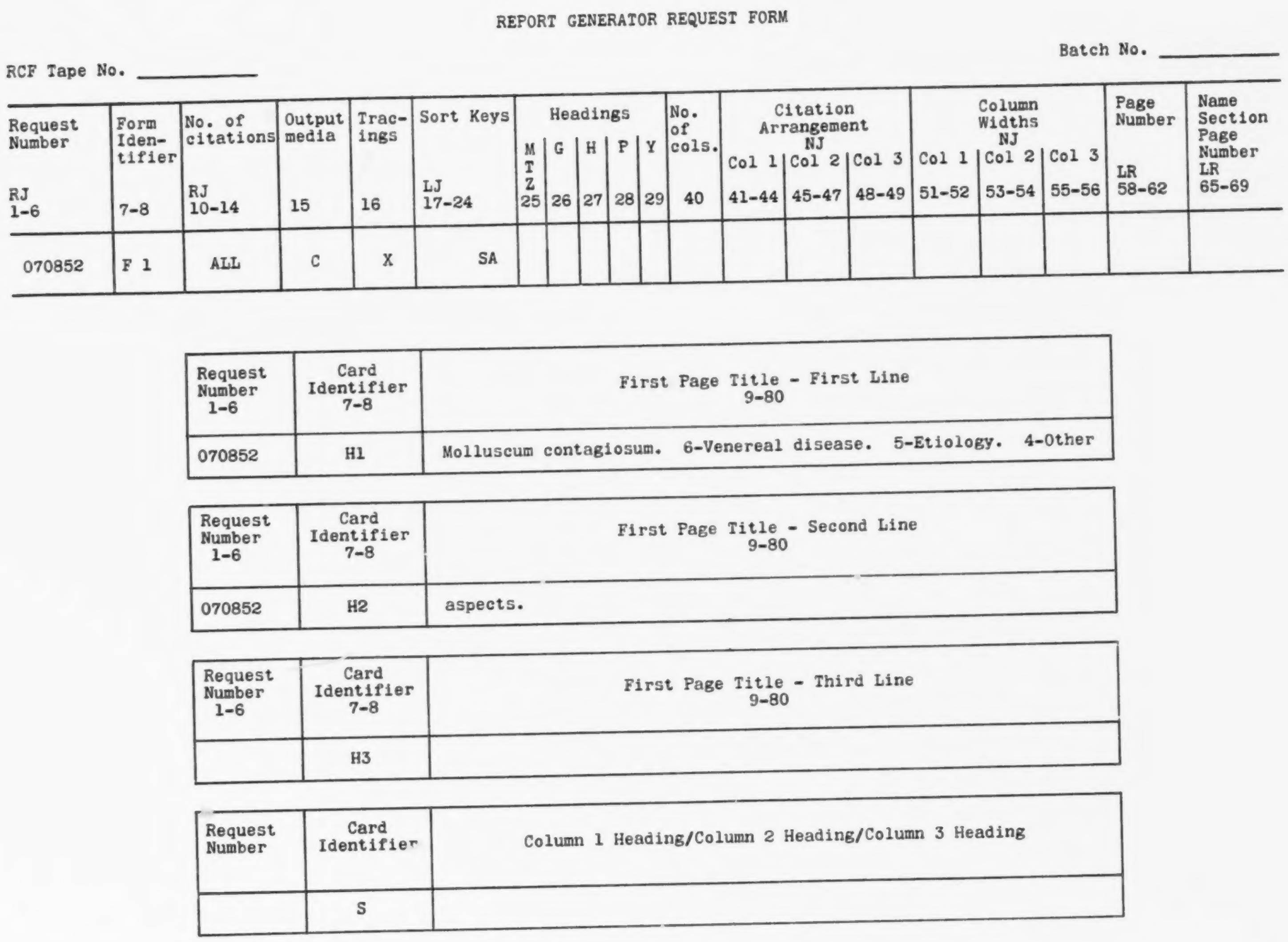
M1=Epilepsy
M2=Epilepsy, grand mal
M3=Epilepsy, petit mal
M4=Sum M1 to M3

After listing and grouping the search elements, the searcher prepares from one to three search statements. Individual elements and sums of elements are linked together into a search equation by use of three operators: OR (+); AND (*); NOT (—). The GREATER THAN OR EQUAL TO (≥) and LESS THAN OR EQUAL TO (≤) operators are used with the computer entry date and year of publication search elements. The searcher has the option of formulating subsearches to provide the simultaneous expression of as many as three levels of increasing specificity (referred to as Sections 4, 5, and 6). The first statement may be a broad expression of needs; the second may introduce limitations; and the third may impose the greatest specificity for the query.

After completing all work on the search formulation itself, the searcher next determines the format for printing each citation in the final bibliography and the sequence of citations (e.g., alphabetic by author names; alphabetic by Journal Title Abbreviation; expanded under subject headings). He chooses from a number of format and sequence options, and records his choices on a Report Generator Request Form (see Figure 17). He may also assign a title to the search by adding this data to the form.

The Search Formulation Record and Report Generator Forms are then sent to the Head of the Search Section for review, prior to conversion to machine-readable input for the computer.

In examining the role of the search specialist, it should be noted that these highly trained and experienced subject specialists serve in an interpretive role between scientist users, indexers, MeSH, and computer facilities. They must develop "hedges" to cope with rigidities of MeSH, develop strategies to compensate for possible inconsistencies or inadequacies of indexing, and develop routines to cope with machine-processing problems which occur. In the original system planning, inadequate consideration was given



REPORT GENERATOR REQUEST FORM

Batch No. ____________

RCF Tape No. ____________

Request Number	Form Identifier	No. of citations	Output media	Tracings	Sort Keys	Headings					No. of cols.	Citation Arrangement NJ			Column Widths NJ			Page Number	Name Section Page Number
						M T Z	G	H	P	Y		Col 1	Col 2	Col 3	Col 1	Col 2	Col 3		
RJ 1-6	7-8	RJ 10-14	15	16	LJ 17-24	25	26	27	28	29	40	41-44	45-47	48-49	51-52	53-54	55-56	LR 58-62	LR 65-69
070852	F 1	ALL	C	X	SA														

Request Number 1-6	Card Identifier 7-8	First Page Title - First Line 9-80
070852	H1	Molluscum contagiosum. 6-Venereal disease. 5-Etiology. 4-Other

Request Number 1-6	Card Identifier 7-8	First Page Title - Second Line 9-80
070852	H2	aspects.

Request Number 1-6	Card Identifier 7-8	First Page Title - Third Line 9-80
	H3	

Request Number	Card Identifier	Column 1 Heading/Column 2 Heading/Column 3 Heading
	S	

Figure 17.—*Specimen Report Generator Request Form.*

to the requirement for training these specialized personnel, and training has occupied a major portion of the time of the supervisors in the Search Section. The intellectual interface between the user and MEDLARS has developed into one of the more challenging and exciting aspects of the total system.

Preparing the Search for Computer Input

Figure 18 depicts the flow of information through the Retrieval Subsystem. The creation of the Demand Search Formulation and Report Generator Request Forms has already been described. The next step is to prepare this information for computer processing.

A clerk in the Search Section matches the Demand Search Formulation to a tub file of prepunched MeSH cards and pulls one card for each subject heading used in the search. The purpose of this step is to cut down on the amount of keypunching required for each search, and—what is perhaps more important—to reduce the possibility of clerical input errors and limit the number of searches rejected by the computer. The prepunched MeSH cards, Demand Search Formulation, and Report Generator Request Forms are then forwarded to the Office of Computer and Engineering Services.

The keypunch operators prepare two decks of cards for each search: a search deck and a report generator deck. In creating the search deck, the keypuncher completes punching of the prepunched subject heading cards, punches new cards for other search elements, and punches new cards for each search statement. The report generator deck includes one format card and up to three header cards with title information for the final bibliography. Both decks are batched with other

MEDLARS RETRIEVAL SUBSYSTEM FLOW CHART

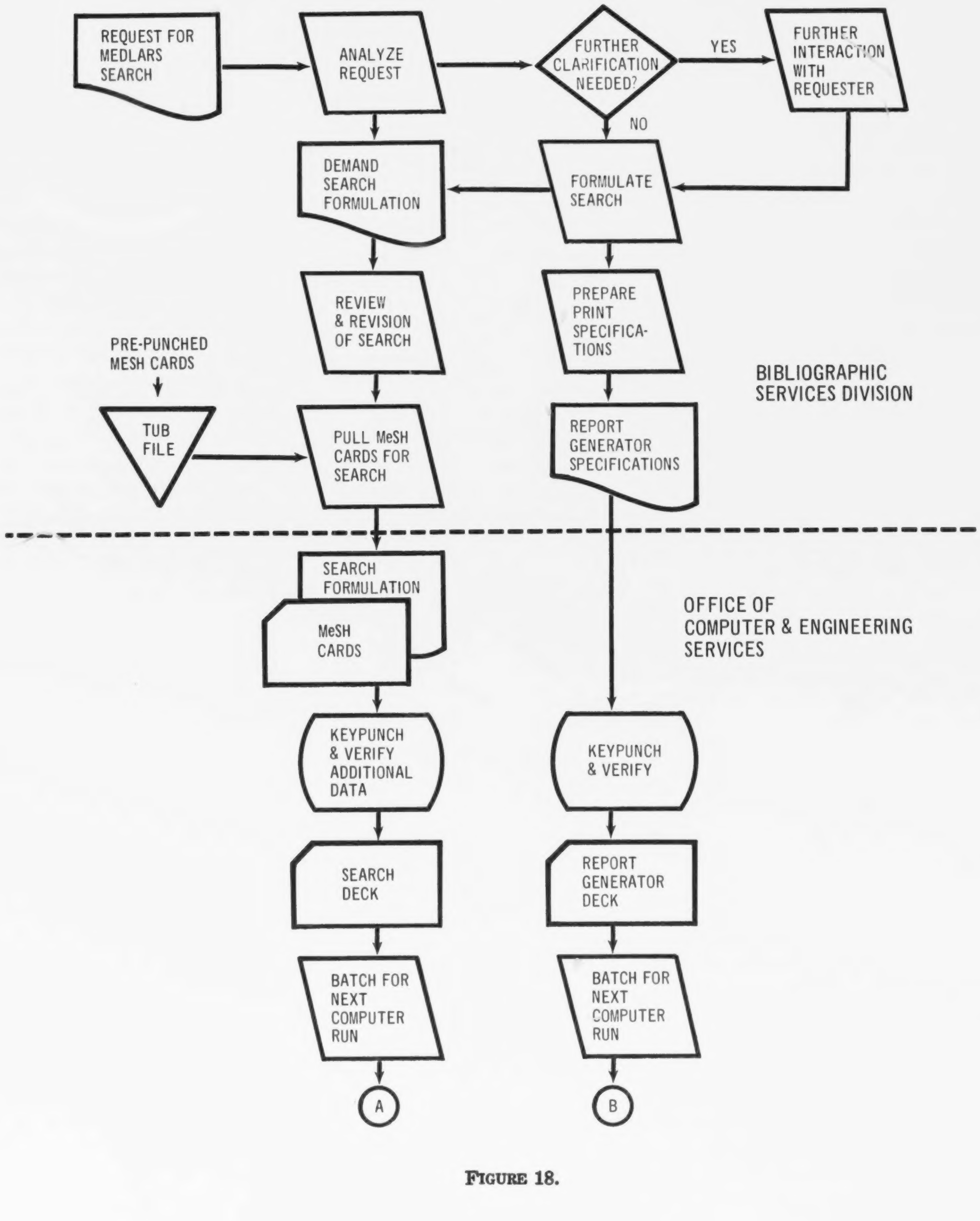

REQUEST FOR MEDLARS SEARCH
ANALYZE REQUEST
FURTHER CLARIFICATION NEEDED?
YES
FURTHER INTERACTION WITH REQUESTER
NO
DEMAND SEARCH FORMULATION
FORMULATE SEARCH
REVIEW & REVISION OF SEARCH
PREPARE PRINT SPECIFICA-TIONS
PRE-PUNCHED MESH CARDS
BIBLIOGRAPHIC SERVICES DIVISION
TUB FILE
PULL MeSH CARDS FOR SEARCH
REPORT GENERATOR SPECIFICATIONS
SEARCH FORMULATION
MeSH CARDS
OFFICE OF COMPUTER & ENGINEERING SERVICES
KEYPUNCH & VERIFY ADDITIONAL DATA
KEYPUNCH & VERIFY
SEARCH DECK
REPORT GENERATOR DECK
BATCH FOR NEXT COMPUTER RUN
BATCH FOR NEXT COMPUTER RUN
A
B

FIGURE 18.

MEDLARS RETRIEVAL SUBSYSTEM FLOW CHART

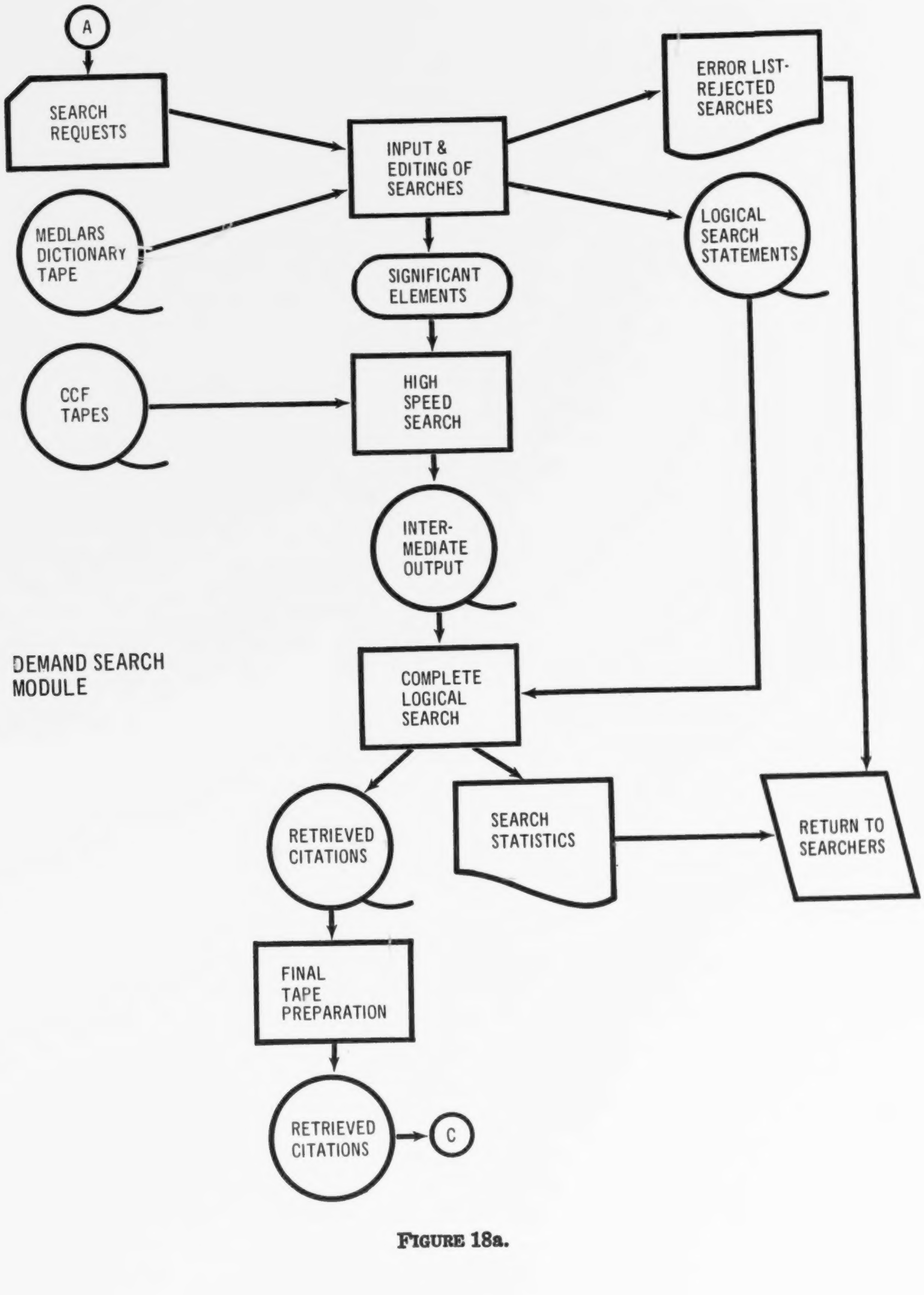

A
SEARCH REQUESTS
MEDLARS DICTIONARY TAPE
INPUT & EDITING OF SEARCHES
ERROR LIST-REJECTED SEARCHES
LOGICAL SEARCH STATEMENTS
SIGNIFICANT ELEMENTS
CCF TAPES
HIGH SPEED SEARCH
INTER-MEDIATE OUTPUT
DEMAND SEARCH MODULE
COMPLETE LOGICAL SEARCH
RETRIEVED CITATIONS
SEARCH STATISTICS
RETURN TO SEARCHERS
FINAL TAPE PREPARATION
RETRIEVED CITATIONS
C

FIGURE 18a.

MEDLARS RETRIEVAL SUBSYSTEM FLOW CHART

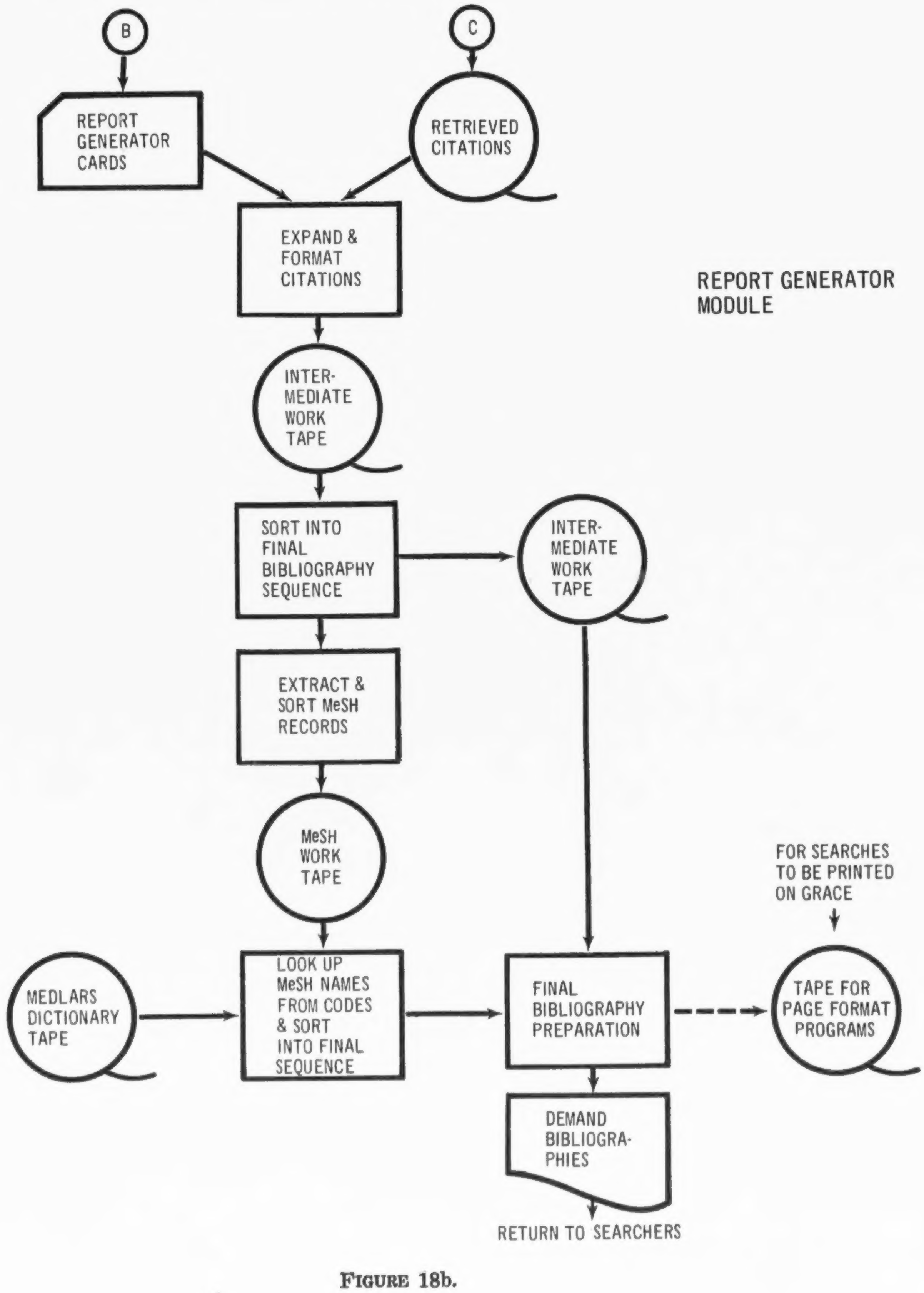

B
C
REPORT GENERATOR CARDS
RETRIEVED CITATIONS
EXPAND & FORMAT CITATIONS
REPORT GENERATOR MODULE
INTER-MEDIATE WORK TAPE
SORT INTO FINAL BIBLIOGRAPHY SEQUENCE
INTER-MEDIATE WORK TAPE
EXTRACT & SORT MeSH RECORDS
MeSH WORK TAPE
FOR SEARCHES TO BE PRINTED ON GRACE
MEDLARS DICTIONARY TAPE
LOOK UP MeSH NAMES FROM CODES & SORT INTO FINAL SEQUENCE
FINAL BIBLIOGRAPHY PREPARATION
TAPE FOR PAGE FORMAT PROGRAMS
DEMAND BIBLIOGRA-PHIES
RETURN TO SEARCHERS

FIGURE 18b.

searches and forwarded to the computer room for processing.

Searching the Computer Files (Demand Search Module)

Programs for searching the computer files of citations are referred to as the Demand Search Module. This module has four major segments or submodules (see Figures 18, 18a, 18b).

The first submodule reads into the computer all search decks in the batch being processed and performs a comprehensive edit of each search. All search element symbols are validated, and the search statements are checked to insure that only valid operators have been used and that the search equations follow the established rules for linking elements and operators. Each subject heading is then split into a separate record along with the search request number. These records are sorted into alphabetic order and matched to the MeSH file on magnetic tape; alphabetic MeSH names are converted to their equivalent code numbers; and the frequency tallies of MeSH term usage are added to the records. The MeSH records are then sorted back into original search number sequence and re-matched to the search records. An average of about 7% to 10% of the searches are rejected by the computer edits.

The next major task performed by this first submodule is the creation of a table of significant elements. A significant element is defined as that element (or elements) in a search which must be present in order for the search to be satisfied and which has a lower frequency of usage than other elements "and'ed" with it in the search statement. An example will help to illustrate the selection of significant elements:

Search Equation:

(A and B) or (C and D and E)

Frequency Tallies:

A — 629
B — 1016
C — 543
D — 816
E — 439

Significant Elements: A and E (i.e., if neither A nor E is present in a citation, the citation *cannot* qualify for the search).

Significant elements are selected for all searches in the batch. Duplicate terms are eliminated and the resulting table of significant elements is stored in internal memory of the computer for use in the next submodule, High Speed Search. The significant element table also includes a code for each search in the batch to which this element applies.

The final task of the edit submodule is to formulate each search in the batch into a logical, decision-table format. These records are written onto magnetic tape for later use in the Logical Search Submodule. The use of the decision table will be explained later.

The High Speed Search Submodule is the only Demand Search Program which requires passing the entire CCF File. The MEDLARS computer system has overlap processing capability; that is, simultaneous reading of one magnetic tape, internal processing, and writing of another tape. In order to minimize the amount of tape-reading time, it is desirable to have tape-read time exceed internal processing time so that no starting and stopping of the tape is required (since some time is lost in acceleration and deceleration of the tape unit). The use of the significant element table in High Speed Search allows this program to process the entire MEDLARS CCF File in a minimum amount of time. The actual tape-processing time for any given search run is a function of the batch size of the searches being processed.

The significant element table is searched for each citation record on the CCF, with citations which match recorded on an intermediate output tape, along with the codes from the significant element table. These codes indicate which of the searches in the batch this citation could satisfy.

The next submodule is the Logical Search. This program reads in the decision tables from magnetic tape and matches the citations retrieved from High Speed Search against these tables.

Note that each citation being searched in the Logical Search Submodule carries a code indicating which search(es) in the batch it could possibly satisfy, and only the appropriate decision tables for each search are

Table 5
Decision Table Logic

Example: M1 * (M2 + M3 +M4)
* = "and"
+ = "or"

Retrieval Element	No Match Code	Match Code
M1	5	0
M2	0	3
M3	0	3
M4	5	3

Match & No Match Codes
0=Examine next element in table
3=Retrieve this citation
5=Reject this citation

No Match on M1 : Reject citation
Match on M1 : Jump to look at M2
No Match on M2 : Look at M3
Match on M2 : Retrieve citation
No Match on M3 : Look at M4
Match on M3 : Retrieve citation
No Match on M4 : Reject citation
Match on M4 : Retrieve citation

examined. Those citations which satisfy the complete logical search criteria are written onto a tape of retrieved citations. Citations satisfying more than one search in the batch are written a multiple number of times on the retrieved file, with each citation identified by a search request number. The Logical Search Submodule also produces a printed listing of each search (and subsearch), showing the number of citations retrieved. This listing is returned to the search specialists.

The fourth submodule prepares the final tape format for the retrieved citation file, sorting the citations into order by search number. If the computer operator notices an unusually large number of citations retrieved, he may check with the searcher before printing this search, since the searcher may choose to print only a few citations and possibly reformulate the search.

The MEDLARS two-phase search logic optimizes the passing of a very large serial magnetic tape file.

Printing the Retrieved Citations (Report Generator Module)

The function of the Report Generator Module is to print demand bibliographies in a variety of formats and sequences (see Figure 18). The module is called "Report Generator" because the computer generates a number of different possible report formats based upon the specifications given to it by the report generator cards (specified by the searcher).

The first program of this module edits the report generator cards for errors and matches these cards to the retrieved citations for each search in the batch. Those searches requiring printing of citations by subject heading are expanded; that is, the citations are copied once for each subject heading to be used in the expansion.

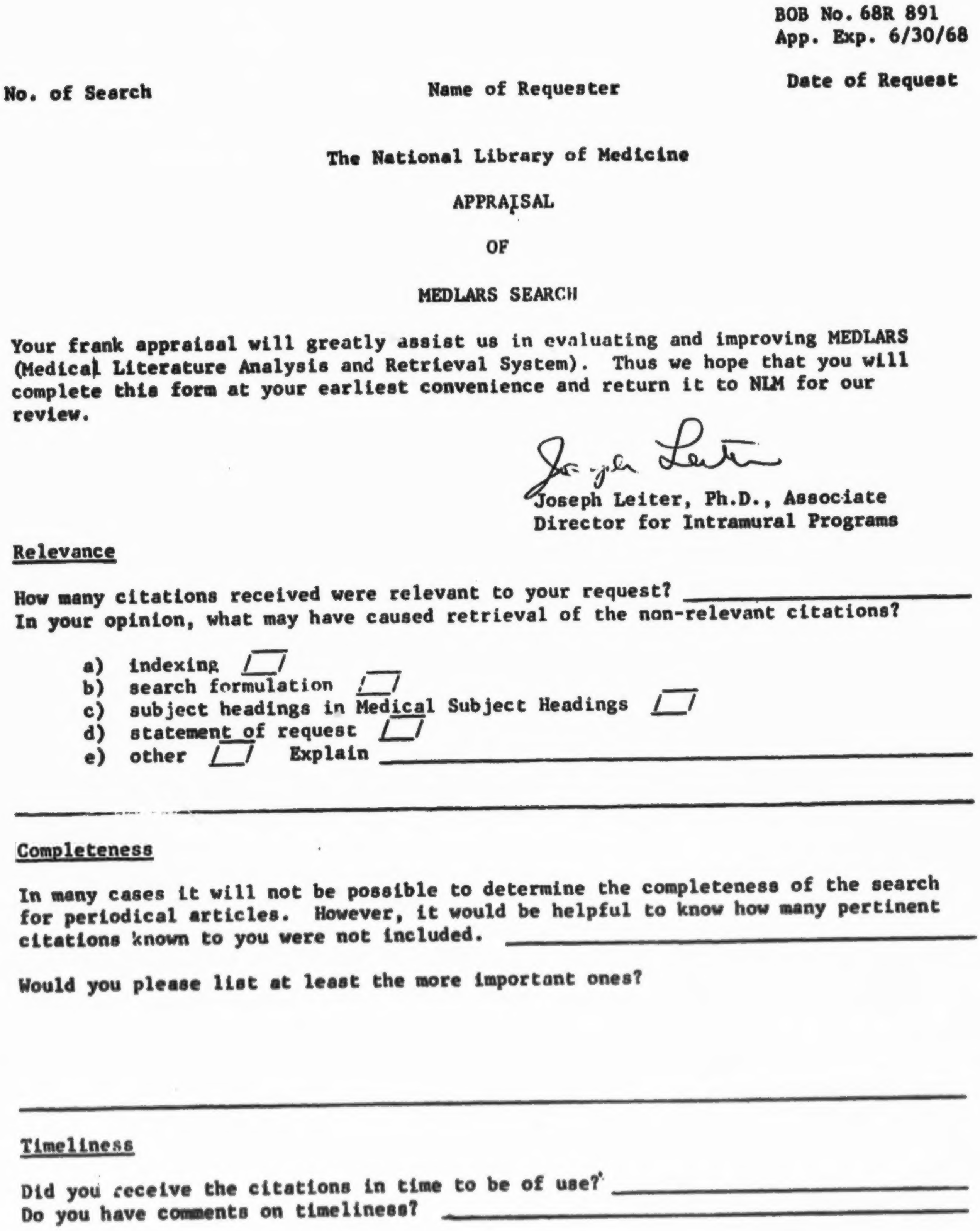
The resulting intermediate work tape next is sorted into final sequence, using the sort keys provided by the report generator cards.

If any of the searches in the batch requires printing of "tracings" (a listing of each subject heading with the printed citations), a third submodule sorts the subject headings into numeric sequence and looks up the alphabetic names on the MeSH file. These are then re-sorted back into search request sequence.

The final submodule creates a magnetic tape for printing of the demand bibliographies on the Honeywell-200 computer. These bibliographies are returned to the Search Section for screening and preliminary evaluation, prior to mailing to the requester. The searchers employ several form letters to explain the results to the requester. In addition, each search is accompanied by an appraisal form requesting a formal evaluation of the search by the user (see Figure 19).

As of January 1, 1968, the average turnaround time for searches (receipt in the Library to mailing of results) was about two weeks. Throughput time varies substantially with the workload, however.

It is also possible to print a demand search on GRACE in those few cases where the demand bibliography is to be widely distributed to a large number of people. In such a case, the Report Generator Module produces a tape which is processed by the Output Module, described in the next chapter.



BOB No. 68R 891
App. Exp. 6/30/68

No. of Search **Name of Requester** **Date of Request**

The National Library of Medicine

APPRAISAL

OF

MEDLARS SEARCH

Your frank appraisal will greatly assist us in evaluating and improving MEDLARS (Medical Literature Analysis and Retrieval System). Thus we hope that you will complete this form at your earliest convenience and return it to NLM for our review.

Joseph Leiter
Joseph Leiter, Ph.D., Associate
Director for Intramural Programs

Relevance

How many citations received were relevant to your request? ____________

In your opinion, what may have caused retrieval of the non-relevant citations?

a) indexing ☐
b) search formulation ☐
c) subject headings in Medical Subject Headings ☐
d) statement of request ☐
e) other ☐ Explain ____________

Completeness

In many cases it will not be possible to determine the completeness of the search for periodical articles. However, it would be helpful to know how many pertinent citations known to you were not included. ____________

Would you please list at least the more important ones?

Timeliness

Did you receive the citations in time to be of use? ____________

Do you have comments on timeliness? ____________

FIGURE 19.—*Specimen Form, Appraisal of MEDLARS Search.*

(Continued on Page 36)

General Comments

General comments not covered above may also be valuable in improving this new experimental service. These comments may be grouped as follows:

a) In your opinion, are Medical Subject Headings (found in Part 2 of Vol. 8, No. 1, January 1967, Index Medicus)

adequate? ☐

inadequate? ☐

If inadequate, do you have comments as to how they may be improved?

b) In your opinion, is the list of Journals covered for Index Medicus (There is a list in the January 1967 issue of Index Medicus)

adequate? ☐

inadequate? ☐

If inadequate, do you have suggestions as to improved coverage?

c) Other

FIGURE 19.—*Continued.*

Chapter V

PUBLICATION SUBSYSTEM

The Publication Subsystem consists of programs and procedures for producing MEDLARS bibliographic publications. A complete list of these publications was given in Chapter II, Table 1. This chapter will discuss the methods followed in preparation of recurring bibliographies and other MEDLARS publications.

Figures 20, 20a, and 20b are flow charts for the Publication Subsystem which is referenced throughout this chapter.

Establishing and Testing Recurring Bibliographies

A recurring bibliography is a periodic selection of citations from current input, structured by a predetermined pattern according to the interest profile of a group. After being contacted by a professional organization with a request for a new recurring bibliography, Library management reviews the request in relation to available resources and makes a decision whether or not to proceed with the new publication. If a decision is made to proceed, several meetings are held with representatives of the cooperating organization to select tentative subject and format parameters for the new bibliography. This selection work is coordinated by a senior staff member of the Search Section, Bibliographic Services Division.

The tentative parameters are tested by running several computer searches to produce "test" copies of the new publication. The results are reviewed jointly by NLM and the cooperating organization, modifications are made, and the search repeated. This testing may require several months' time, depending upon the complexity of the subject. In some cases, the test bibliographies are mailed to a select group of outside experts for review before the final parameters are selected.

After the test search has been approved, the final specifications are forwarded to the Input Unit, where recurring bibliography search and format specification cards are keypunched and verified. The search specification cards, which are punched in the format required for the Demand Search Module, are filed and held until time to run the recurring bibliography. The format specifications are added to the recurring bibliography format parameter file.

Computer Programs for Producing MEDLARS Publications

The recurring bibliography search cards are pulled from the file when the publication is scheduled to be run. (Note that the frequency of publication varies from monthly to annual, depending upon the recurring bibliography in question.)

The search cards are run through the Demand Search Module (see Chapter IV) and the citations which satisfy the search are written onto tape—the Retrieved Citation File (RCF). Note that in running the Demand Search Module, only the "current" CCF tapes are searched; that is, those new citations added to the file since the last run of the publication. This is controlled by the date card input as part of the search.

The next computer job is running the Recurring Bibliography Submodule (see Figure 20). This submodule processes the RCF tape for the recurring bibliographies and formats each citation on the RCF into standard print formats. Each character of the citation is converted to a special code required for GRACE, and the citation elements are arranged in the correct format for printing. A

MEDLARS PUBLICATION SUBSYSTEM FLOW CHART

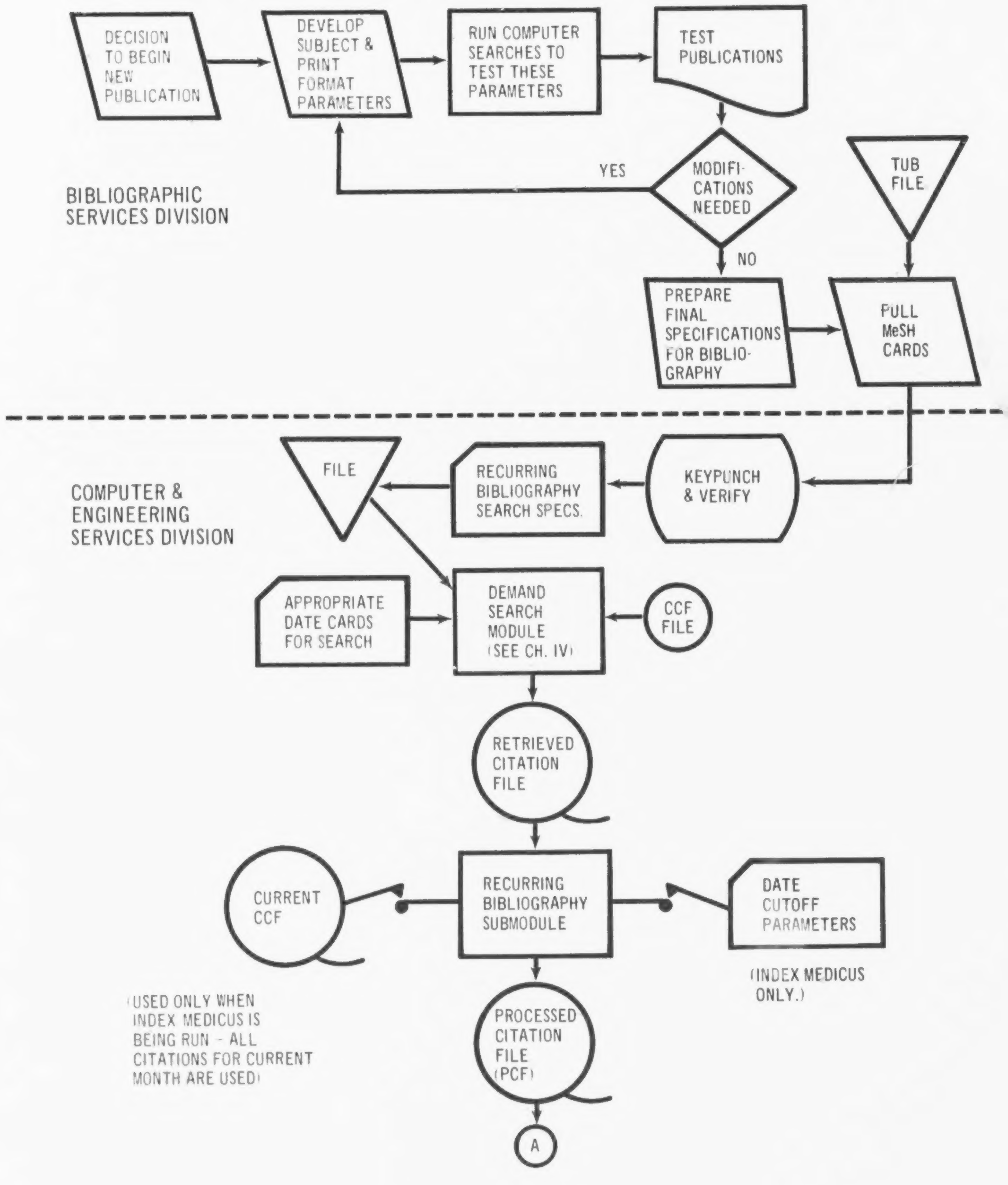

DECISION TO BEGIN NEW PUBLICATION
DEVELOP SUBJECT & PRINT FORMAT PARAMETERS
RUN COMPUTER SEARCHES TO TEST THESE PARAMETERS
TEST PUBLICATIONS
MODIFICATIONS NEEDED
YES
NO
BIBLIOGRAPHIC SERVICES DIVISION
TUB FILE
PREPARE FINAL SPECIFICATIONS FOR BIBLIOGRAPHY
PULL MeSH CARDS
COMPUTER & ENGINEERING SERVICES DIVISION
FILE
RECURRING BIBLIOGRAPHY SEARCH SPECS.
KEYPUNCH & VERIFY
APPROPRIATE DATE CARDS FOR SEARCH
DEMAND SEARCH MODULE (SEE CH. IV)
CCF FILE
RETRIEVED CITATION FILE
CURRENT CCF
RECURRING BIBLIOGRAPHY SUBMODULE
DATE CUTOFF PARAMETERS
(INDEX MEDICUS ONLY.)
(USED ONLY WHEN INDEX MEDICUS IS BEING RUN - ALL CITATIONS FOR CURRENT MONTH ARE USED)
PROCESSED CITATION FILE (PCF)
A

FIGURE 20.

MEDLARS PUBLICATION SUBSYSTEM FLOW CHART

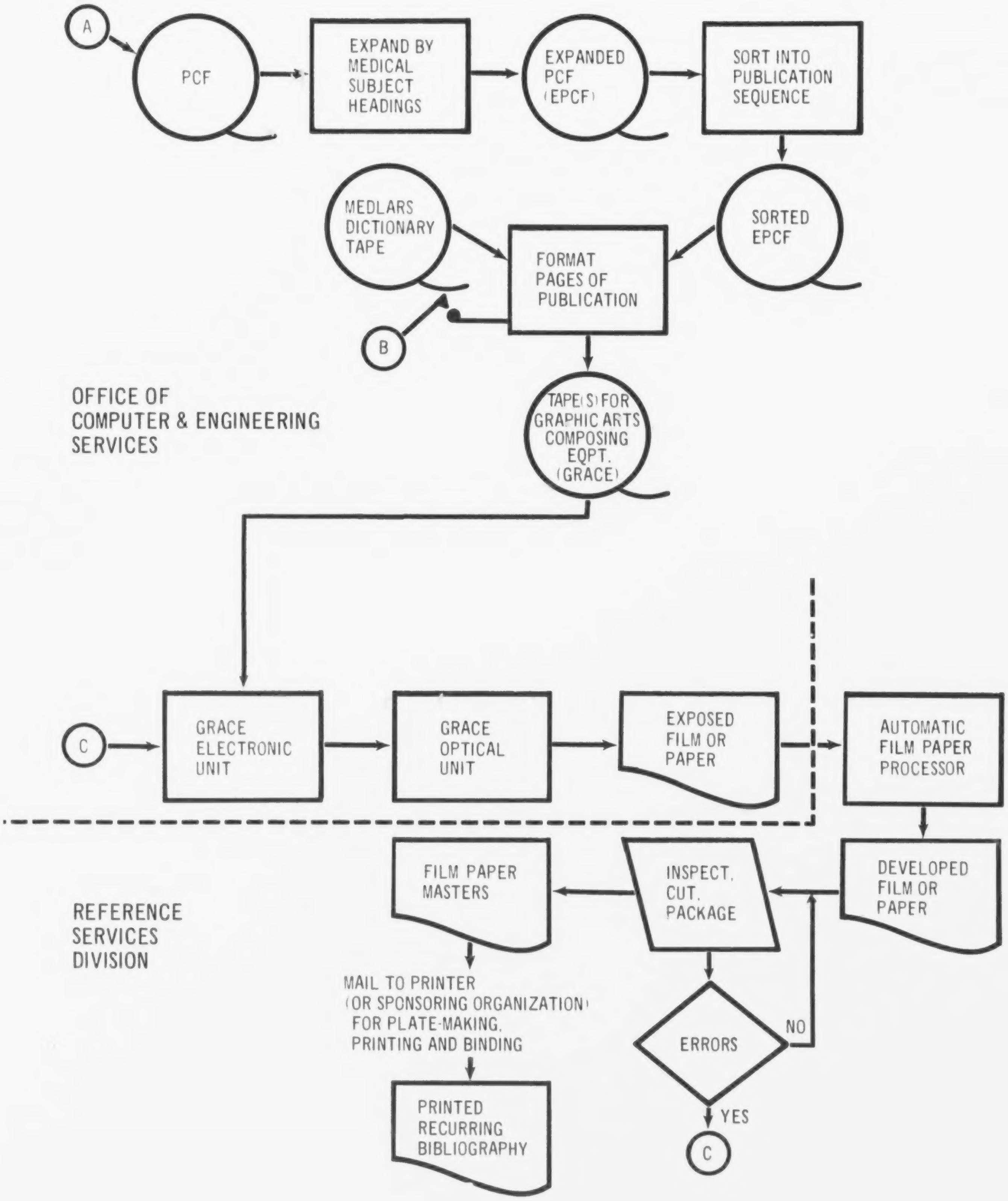

A
PCF
EXPAND BY MEDICAL SUBJECT HEADINGS
EXPANDED PCF (EPCF)
SORT INTO PUBLICATION SEQUENCE
MEDLARS DICTIONARY TAPE
SORTED EPCF
FORMAT PAGES OF PUBLICATION
B
TAPE(S) FOR GRAPHIC ARTS COMPOSING EQPT. (GRACE)
OFFICE OF COMPUTER & ENGINEERING SERVICES
C
GRACE ELECTRONIC UNIT
GRACE OPTICAL UNIT
EXPOSED FILM OR PAPER
AUTOMATIC FILM PAPER PROCESSOR
REFERENCE SERVICES DIVISION
FILM PAPER MASTERS
INSPECT, CUT, PACKAGE
DEVELOPED FILM OR PAPER
MAIL TO PRINTER (OR SPONSORING ORGANIZATION) FOR PLATE-MAKING, PRINTING AND BINDING
ERRORS
NO
YES
C
PRINTED RECURRING BIBLIOGRAPHY

Figure 20a.

MEDLARS PUBLICATION SUBSYSTEM FLOW CHART

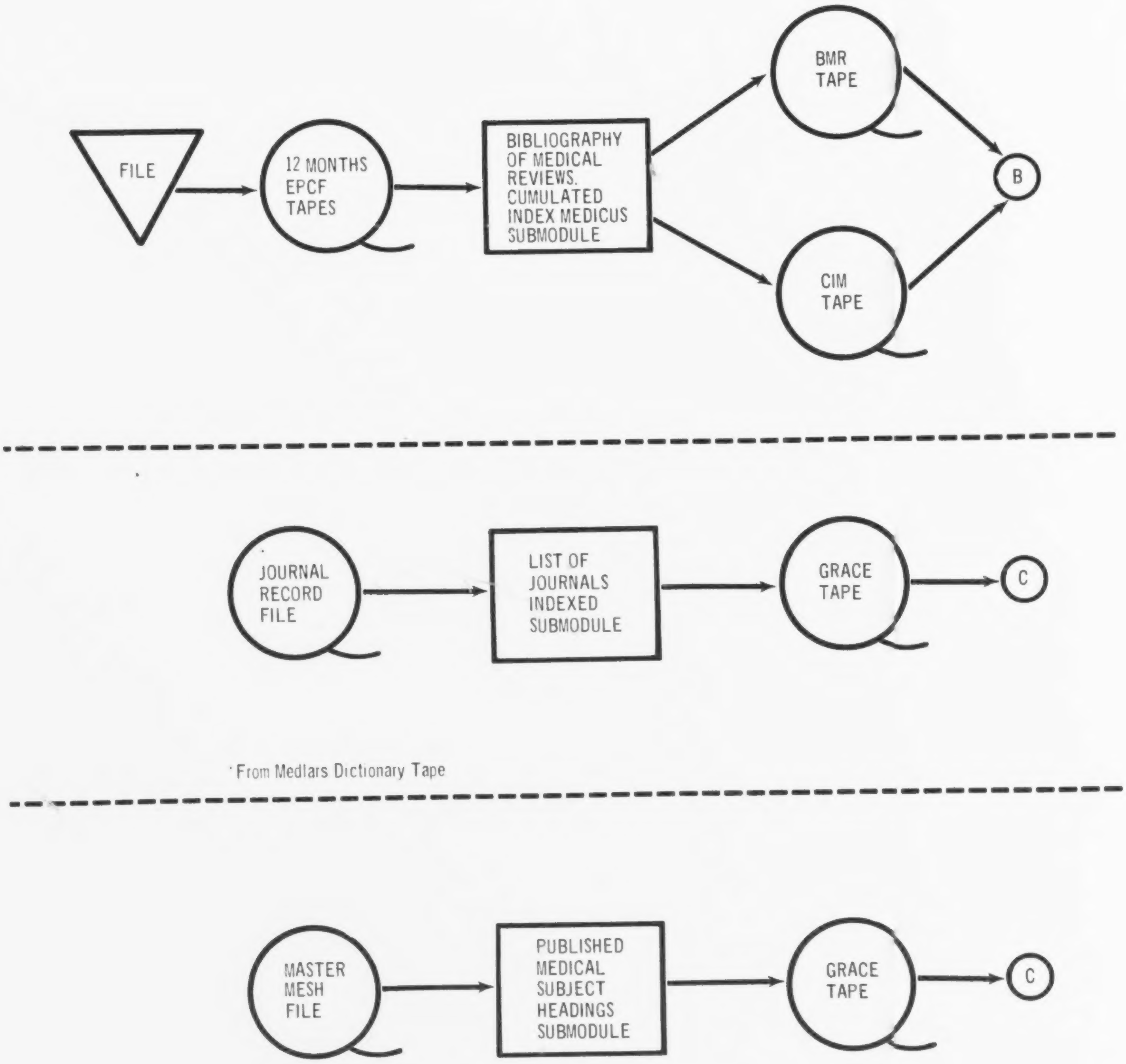

FILE
12 MONTHS EPCF TAPES
BIBLIOGRAPHY OF MEDICAL REVIEWS. CUMULATED INDEX MEDICUS SUBMODULE
BMR TAPE
CIM TAPE
B
JOURNAL RECORD FILE
LIST OF JOURNALS INDEXED SUBMODULE
GRACE TAPE
C
·From Medlars Dictionary Tape
MASTER MESH FILE
PUBLISHED MEDICAL SUBJECT HEADINGS SUBMODULE
GRACE TAPE
C

Figure 20b.

partial right-margin justification is also performed by varying the amount of blank space between words of the citation. The resulting formatted citations are written onto another magnetic tape called the Processed Citation File or PCF.

The Recurring Bibliography Submodule also is used to create a PCF tape for the monthly *Index Medicus*. Since almost all new citations entering the system go into *Index Medicus*, it is not necessary to run the Demand Search Module for this publication. Rather, the new CCF file for the month is input directly into this submodule with the appropriate date cards.

The programs which process the PCF and produce the final tapes for printing are called the Output Module (see Figure 20).

A submodule expands each citation by subject heading, creating an Expanded Processed Citation File (EPCF). The EPCF is then sorted into final bibliography sequence, and a Format Submodule produces a tape for the Photocomposer—GRACE. Note that in the case of *Index Medicus*, the twelve monthly EPCF tapes are saved for the annual cumulation.

The formatting programs are quite complex, since they must deal with various formats (1, 2, or 3 columns per page, etc.). In addition, the programs handle such things as page headings, intermediate headings within columns, and continuous page numbers (see Figure 21).

The Output Module includes three other submodules for producing four special MEDLARS publications. The BMR/CIM Submodule takes the twelve monthly EPCF files (which have been collated by subject and author) and produces two sets of tapes—one for the *Cumulated Index Medicus* and another for the annual *Bibliography of Medical Reviews*. These tapes are processed by the Format Submodule to create tapes for GRACE. The LJI (List of Journals Indexed) Submodule uses the Journal Record File (JRF), created by the Input Module (see Chapter III), and creates a tape for GRACE. Similarly, the MeSH Submodule creates a GRACE tape for the annual printed list of subject headings, working from the master MeSH file.

The MEDLARS Photocomposer (GRACE)

Tapes produced by the Output Module are processed by the Photon 900 computer phototypesetter—GRACE.

GRACE consists of three components. Print lines are delivered from a standard Honeywell magnetic tape drive. The electronic control unit of GRACE includes an operator control panel, an input converter, a small amount of core storage, and special-purpose logical circuitry which computes timing signals for driving the optical unit. The optical unit has five major subassemblies: flash tubes, a matrix of characters etched onto glass plates, a reciprocating lens, a mirror block assembly, and film handling unit. The lens makes one complete horizontal sweep for each print line, during which time the control unit sends a signal to each of the flash tubes at the exact instant required to expose the appropriate character at its proper position on the film. As the lens sweep is completed, the film is advanced, a new record is read, and the cycle is repeated (see Schematic Diagram, Figure 22).

The final product produced by the optical unit of GRACE is a roll of exposed film or paper, full size, 9″ wide by approximately 120′ long. Each roll holds about 120 pages for publication.*

Final Processing

After the tapes have been run through GRACE, the exposed film or paper is developed by an automatic processer—a Kodak Versamat.

The developed film or paper then is sent to a quality control station where it is inspected, cut into page-size sheets, and packaged for delivery to a commercial printer. Offset printing and binding completes the publication cycle.

For a MEDLARS recurring bibliography, the above cycle is run twice. A galley proof

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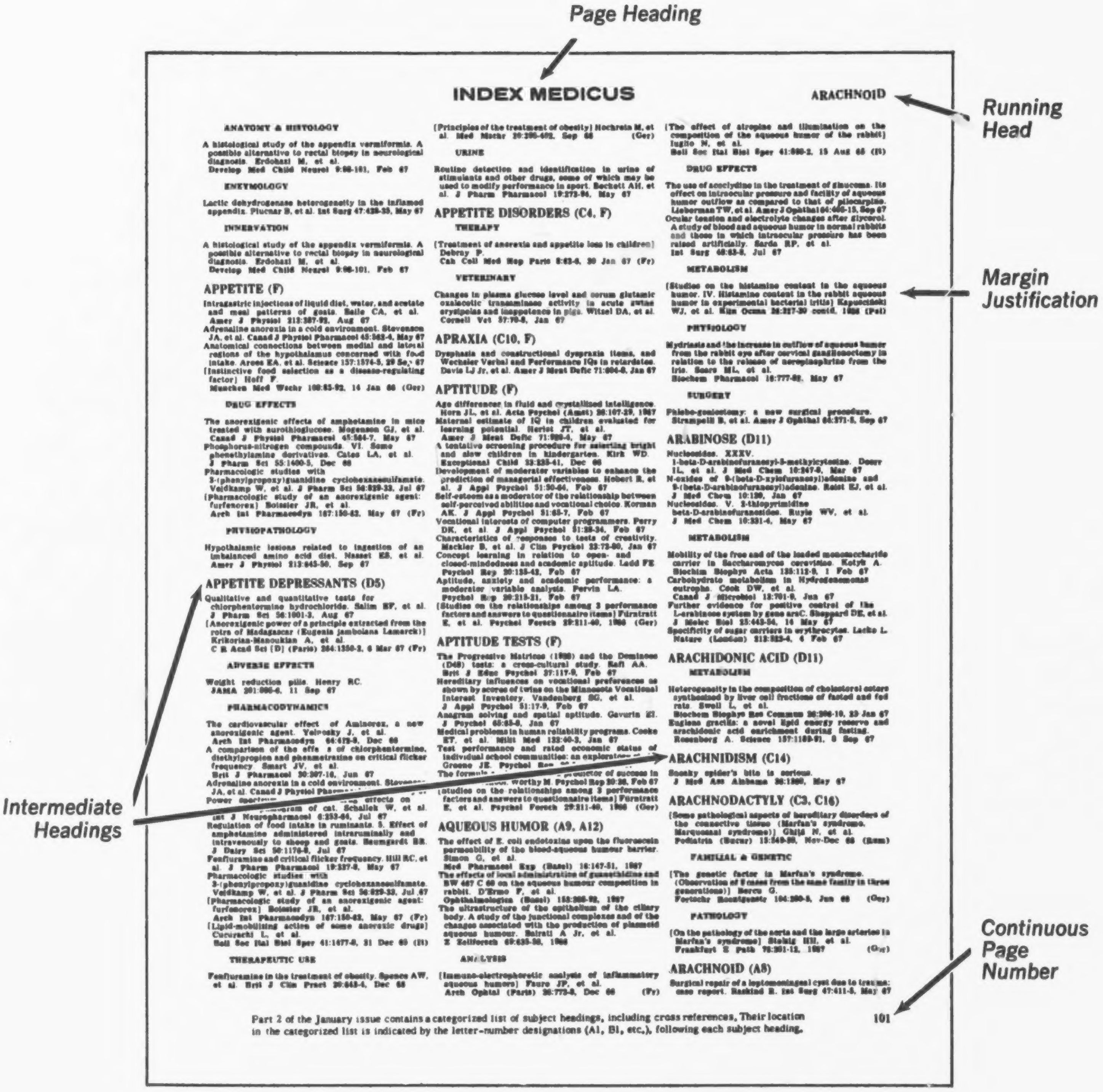
*For a more complete description of GRACE see: Paul C. Redmer, Publication by GRACE, *Methods of Information in Medicine*, 4:145–50, September 1965.



INDEX MEDICUS

ARACHNOID

ANATOMY & HISTOLOGY

A histological study of the appendix vermiformis. A possible alternative to rectal biopsy in neurological diagnosis. Erdohazi M, et al.
Develop Med Child Neurol 9:98-101, Feb 67

ENZYMOLOGY

Lactic dehydrogenase heterogeneity in the inflamed appendix. Plucnar B, et al. Int Surg 47:428-35, May 67

INNERVATION

A histological study of the appendix vermiformis. A possible alternative to rectal biopsy in neurological diagnosis. Erdohazi M, et al.
Develop Med Child Neurol 9:98-101, Feb 67

APPETITE (F)

Intragastric injections of liquid diet, water, and acetate and meal patterns of goats. Baile CA, et al. Amer J Physiol 213:387-93, Aug 67
Adrenaline anorexia in a cold environment. Stevenson JA, et al. Canad J Physiol Pharmacol 45:563-4, May 67
Anatomical connections between medial and lateral regions of the hypothalamus concerned with food intake. Arees EA, et al. Science 157:1574-5, 29 Sep 67
[Instinctive food selection as a disease-regulating factor] Hoff F.
Munchen Med Wschr 108:85-92, 14 Jan 66 (Ger)

DRUG EFFECTS

The anorexigenic effects of amphetamine in mice treated with aurothioglucose. Mogenson GJ, et al. Canad J Physiol Pharmacol 45:584-7, May 67
Phosphorus-nitrogen compounds. VI. Some phenethylamine derivatives. Cates LA, et al. J Pharm Sci 55:1400-5, Dec 66
Pharmacologic studies with 3-(phenylpropoxy)guanidine cyclohexanesulfamate. Veldkamp W, et al. J Pharm Sci 56:829-33, Jul 67
[Pharmacologic study of an anorexigenic agent: furfenorex] Boissier JR, et al.
Arch Int Pharmacodyn 167:150-62, May 67 (Fr)

PHYSIOPATHOLOGY

Hypothalamic lesions related to ingestion of an imbalanced amino acid diet. Nasset ES, et al. Amer J Physiol 213:645-50, Sep 67

APPETITE DEPRESSANTS (D5)

Qualitative and quantitative tests for chlorphentermine hydrochloride. Salim EF, et al. J Pharm Sci 56:1001-3, Aug 67
[Anorexigenic power of a principle extracted from the rotra of Madagascar (Eugenia jambolana Lamarck)] Krikorian-Manoukian A, et al.
C R Acad Sci [D] (Paris) 264:1350-2, 6 Mar 67 (Fr)

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The cardiovascular effect of Aminorex, a new anorexigenic agent. Yelnosky J, et al.
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Power spectrum [illegible] effects on [illegible] gram of cat. Schallek W, et al. Int J Neuropharmacol 6:253-64, Jul 67
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[Lipid-mobilizing action of some anorexic drugs] Cucurachi L, et al.
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Fenfluramine in the treatment of obesity. Spence AW, et al. Brit J Clin Pract 20:643-4, Dec 66
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Routine detection and identification in urine of stimulants and other drugs, some of which may be used to modify performance in sport. Beckett AH, et al. J Pharm Pharmacol 19:273-94, May 67

APPETITE DISORDERS (C4, F)

THERAPY

[Treatment of anorexia and appetite loss in children] Debray P.
Cah Coll Med Hop Paris 8:63-6, 30 Jan 67 (Fr)

VETERINARY

Changes in plasma glucose level and serum glutamic oxalacetic transaminase activity in acute swine erysipelas and inappetence in pigs. Witzel DA, et al. Cornell Vet 57:70-8, Jan 67

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Dysphasia and constructional dyspraxia items, and Wechsler Verbal and Performance IQs in retardates. Davis LJ Jr, et al. Amer J Ment Defic 71:604-8, Jan 67

APTITUDE (F)

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The Progressive Matrices (1938) and the Dominoes (D48) tests: a cross-cultural study. Kafi AA.
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[Immuno-electrophoretic analysis of inflammatory aqueous humors] Faure JP, et al.
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METABOLISM

[Studies on the histamine content in the aqueous humor. IV. Histamine content in the rabbit aqueous humor in experimental bacterial iritis] Kapuscinski WJ, et al. Klin Oczna 36:227-30 contd, 1966 (Pol)

PHYSIOLOGY

Mydriasis and the increase in outflow of aqueous humor from the rabbit eye after cervical ganglionectomy in relation to the release of norepinephrine from the iris. Sears ML, et al.
Biochem Pharmacol 16:777-82, May 67

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Nucleosides. XXXV. 1-beta-D-arabinofuranosyl-5-methylcytosine. Doerr IL, et al. J Med Chem 10:247-9, Mar 67
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Canad J Microbiol 13:701-9, Jun 67
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Specificity of sugar carriers in erythrocytes. Lacko L. Nature (London) 213:323-4, 4 Feb 67

ARACHIDONIC ACID (D11)

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Euglena gracilis: a novel lipid energy reserve and arachidonic acid enrichment during fasting. Rosenberg A. Science 157:1189-91, 8 Sep 67

ARACHNIDISM (C14)

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J Med Ass Alabama 36:1390, May 67

ARACHNODACTYLY (C3, C16)

[Some pathological aspects of hereditary disorders of the connective tissue (Marfan's syndrome, Marquesani syndrome)] Ghiţă N, et al.
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FAMILIAL & GENETIC

[The genetic factor in Marfan's syndrome. (Observation of 8 cases from the same family in three generations)] Bercu G.
Fortschr Roentgenstr 104:390-5, Jun 66 (Ger)

PATHOLOGY

[On the pathology of the aorta and the large arteries in Marfan's syndrome] Stelzig HH, et al.
Frankfurt Z Path 76:201-12, 1967 (Ger)

ARACHNOID (A8)

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Part 2 of the January issue contains a categorized list of subject headings, including cross references, Their location in the categorized list is indicated by the letter-number designations (A1, B1, etc.), following each subject heading.

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FIGURE 21.—*Sample INDEX MEDICUS Page.*

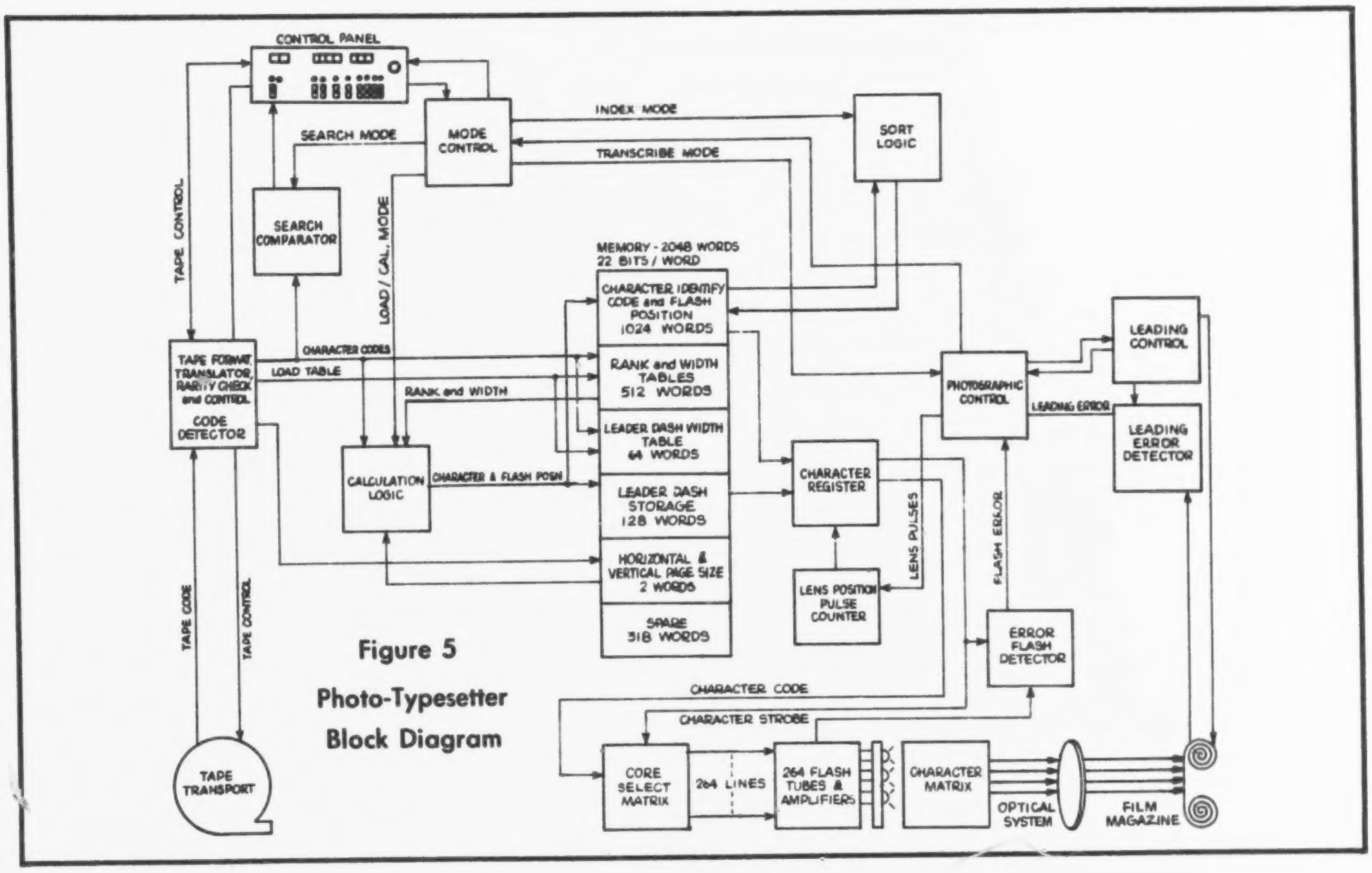

CONTROL PANEL
MODE CONTROL
SEARCH MODE
INDEX MODE
TRANSCRIBE MODE
SORT LOGIC
TAPE CONTROL
SEARCH COMPARATOR
LOAD / CAL. MODE
MEMORY - 2048 WORDS
22 BITS / WORD
CHARACTER IDENTIFY CODE and FLASH POSITION 1024 WORDS
RANK and WIDTH TABLES 512 WORDS
LEADER DASH WIDTH TABLE 64 WORDS
LEADER DASH STORAGE 128 WORDS
HORIZONTAL & VERTICAL PAGE SIZE 2 WORDS
SPARE 318 WORDS
TAPE FORMAT TRANSLATOR, PARITY CHECK and CONTROL
CODE DETECTOR
CHARACTER CODES
LOAD TABLE
RANK and WIDTH
CALCULATION LOGIC
CHARACTER & FLASH POSN
CHARACTER REGISTER
LENS POSITION PULSE COUNTER
LENS PULSES
PHOTOGRAPHIC CONTROL
LEADING ERROR
LEADING CONTROL
LEADING ERROR DETECTOR
FLASH ERROR
ERROR FLASH DETECTOR
TAPE CODE
TAPE CONTROL
TAPE TRANSPORT
Figure 5
Photo-Typesetter
Block Diagram
CHARACTER CODE
CHARACTER STROBE
CORE SELECT MATRIX
264 LINES
264 FLASH TUBES & AMPLIFIERS
CHARACTER MATRIX
OPTICAL SYSTEM
FILM MAGAZINE

FIGURE 22.—*Schematic Diagram of GRACE Optical Unit.*

copy is run first and sent to the Senior Scientific Editor, who checks it for scientific accuracy (of indexing) and for any obvious mechanical errors. Corrections, if necessary, are made via File Maintenance Programs and the final copy for the publication is produced. Because of its size, this procedure is not followed for *Index Medicus.*

Index Medicus, NLM Current Catalog, Medical Subject Headings, List of Journals Indexed, Monthly Bibliography of Medical Reviews, and *Cumulated Index Medicus* are distributed by the Superintendent of Documents, U.S. Government Printing Office; recurring bibliographies are distributed by the cooperating organizations.

Chapter VI

UTILITY PROGRAMS

Chapters III, IV, and V have described the main operating computer programs of MEDLARS. In addition, there are several Utility Modules which support the operating programs and which are quite important. These utility programs consist of three modules and a miscellaneous category, as described below.

Updating the Subject Headings File (MeSH Generator Module)

The Medical Subject Headings File (MeSH), described in detail in Chapter III, is maintained and updated by the professional staff of the MeSH Section, Bibliographic Services Division. This staff of experienced lexicographers and clerical assistants produces additional and changes to MeSH for updating the magnetic tape file in the computer system.

MeSH is revised once a year and printed in a separate volume accompanying the January issue of *Index Medicus.* A considerable amount of time is spent reviewing and selecting each new heading for the annual revision. The subject heading specialists produce a New Heading Work Sheet for every new term entering the system.

This work sheet provides the new alphabetic MeSH name, the definition and scope note for indexing, information on authority for the new term, how this concept was previously indexed, place in the tree structure for the term, relation to cross references, and file maintenance required of the CCF (if any). In addition to new subject headings, the subject heading specialists also produce other changes to the MeSH file, including heading and cross-reference changes, and withdrawing old headings.

A clerical assistant in the MeSH Section assigns to the terminology to be changed the necessary code numbers required for the computer and produces the source documents for keypunching. Figure 23 depicts the flow of information for MeSH maintenance.

The MeSH Generator Module matches the MeSH change cards (which can include new terms, changes, and deletion of old terms) to the MeSH file on magnetic tape and makes the appropriate changes to the file. This module is run throughout the year to add and delete provisional headings. At the end of each year, the module is run to apply all the changes created for the annual revision. The module also is used to produce the annual MeSH file which includes cross-references for *Cumulated Index Medicus* and the annual *Bibliography of Medical Reviews* (see Chapter V). The final function of the MeSH Generator Module is preparation of printed MeSH lists used internally by NLM staff, including lists showing the MeSH hierarchical tree structure.

Maintaining the Compressed Citation File (File Maintenance Module)

Many situations create the requirement for the ability to make changes to the master file of citations (CCF). Errors in citations already on tape are frequently detected by NLM staff, users of *Index Medicus* and recurring bibliographies, and recipients of demand searches. In addition, the annual revision to MeSH requires that corrections be made to the CCF in cases where a one-for-one substitution of terms or a deletion of terms has occurred. (It is not possible to correct the CCF when a general subject heading is replaced by several more specific terms; MeSH is therefor revised only once a year,

MeSH GENERATOR FLOW CHART

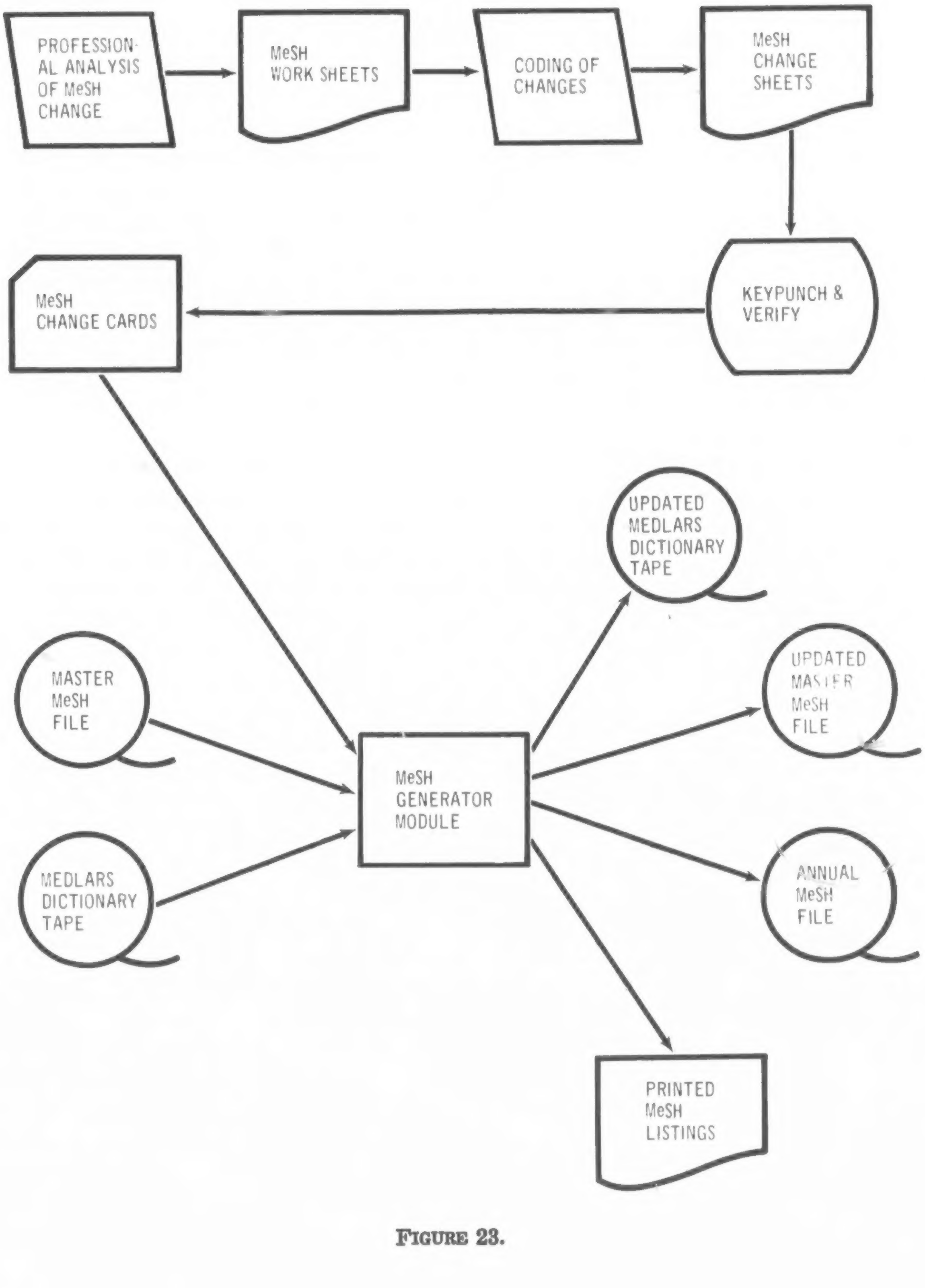

PROFESSIONAL ANALYSIS OF MeSH CHANGE
MeSH WORK SHEETS
CODING OF CHANGES
MeSH CHANGE SHEETS
KEYPUNCH & VERIFY
MeSH CHANGE CARDS
UPDATED MEDLARS DICTIONARY TAPE
MASTER MeSH FILE
UPDATED MASTER MeSH FILE
MeSH GENERATOR MODULE
MEDLARS DICTIONARY TAPE
ANNUAL MeSH FILE
PRINTED MeSH LISTINGS

FIGURE 23.

FILE MAINTENANCE FLOW CHART

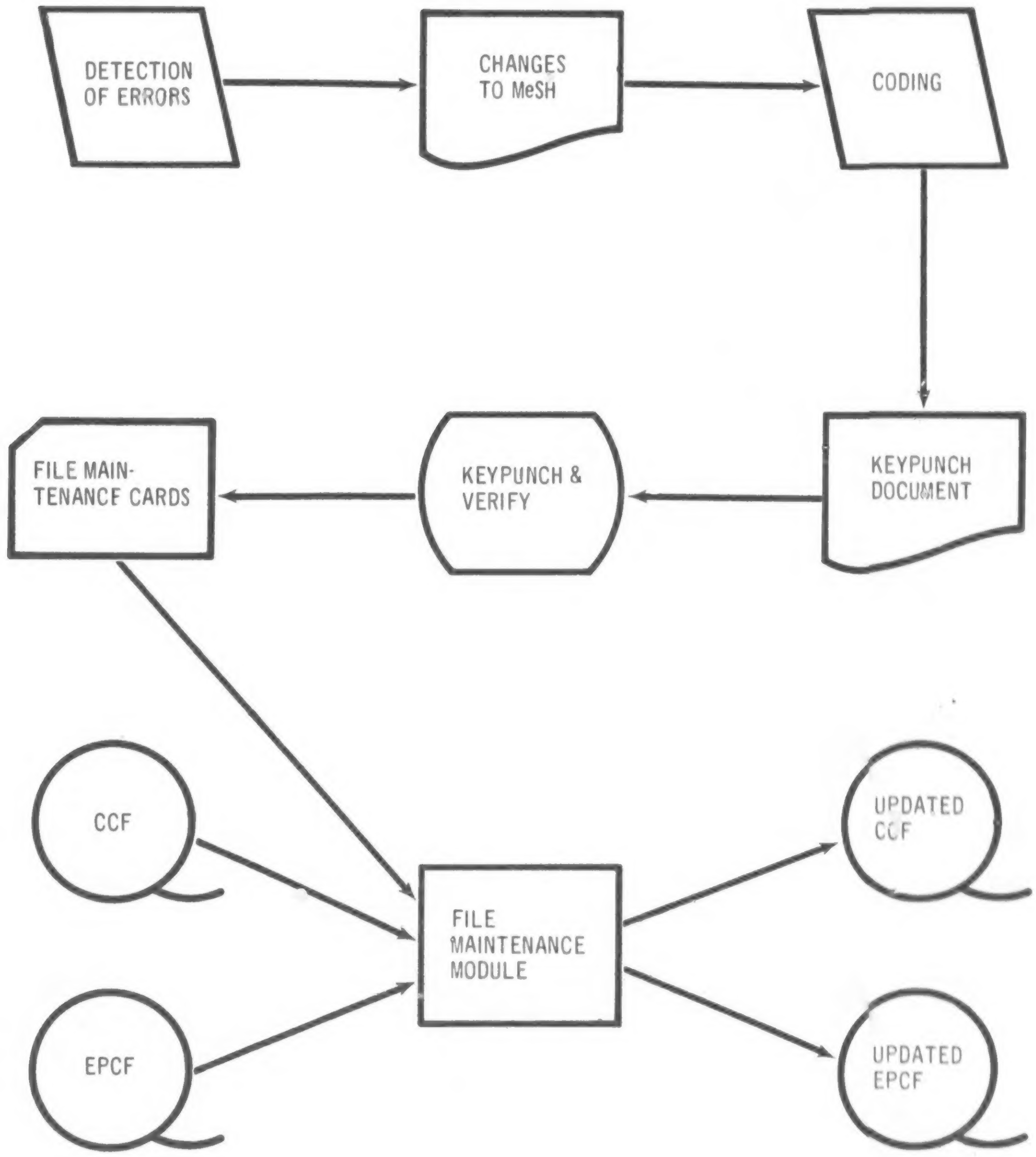

DETECTION OF ERRORS
CHANGES TO MeSH
CODING
KEYPUNCH DOCUMENT
KEYPUNCH & VERIFY
FILE MAIN-TENANCE CARDS
CCF
EPCF
FILE MAINTENANCE MODULE
UPDATED CCF
UPDATED EPCF

FIGURE 24.

since the searcher must consider these general-specific MeSH changes in formulating a search.)

File maintenance changes to the CCF originate in the Index Section, Search Section, and MeSH Section. Figure 24 shows the flow of information for file maintenance.

After keypunching and verification, the change cards are processed by the File Maintenance Module which corrects the appropriate records on the CCF. Note also that the Expanded Processed Citation Files (EPCF) for the twelve monthly issues of *Index Medicus*, which are saved and cumulated for the *CIM* (see Chapter V), are also corrected by the File Maintenance Module.

Maintenance of the entire CCF file (25 reels as of January 1, 1968) is a time-consuming job. This is normally done only once a year, following the annual MeSH revision.

Reports of System Activity (Statistical Module)

The Statistical Module produces management reports for the Library staff operating MEDLARS. Table 6 shows the reports which are available from this module.

The module is run monthly, quarterly, and on an annual cycle to produce the reports described above. Figure 25 shows the structure of the Statistical Module Programs. A parameter card is punched, specifying which of the eight statistical reports are to be produced and what period of time is to be covered. These parameters are matched against the MeSH file and the appropriate CCF tapes to produce the printed reports.

Miscellaneous Utility Programs

In addition to the three modules described above, other utility programs are used in the MEDLARS system as needed. These include such routines as generalized sort and merge programs provided by the computer manufacturer, programs to copy magnetic tape files, i.e., the CCF and MeSH files for use at decentralized MEDLARS Stations (as described in Chapter VII).

Table 6

Statistical Module Reports

Report Name	Description
Journal Report	List of journals indexed during the period, with date of publication of each.
Main Heading/Subheading Usage	Frequency of main heading/subheading usage with a breakdown as to *Index Medicus*—(IM) or non-IM.
Language Report	Total number of articles in English indexed; total number of foreign articles indexed with breakdown by language.
Index Medicus Statistics	Number of citations in Subject Section, Name Section, and number of junior author cross-references in *Index Medicus*.
BMR Statistics	Number of articles indexed for *Bibliography of Medical Reviews*.
Category Usage	Number of times each category of terms in the MeSH tree structure is used.
Indexer Statistics	Average depth of indexing by each member of the indexing staff.
High Volume Headings	List of large volume main headings and most frequently used provisional headings.

STATISTICAL MODULE FLOW CHART

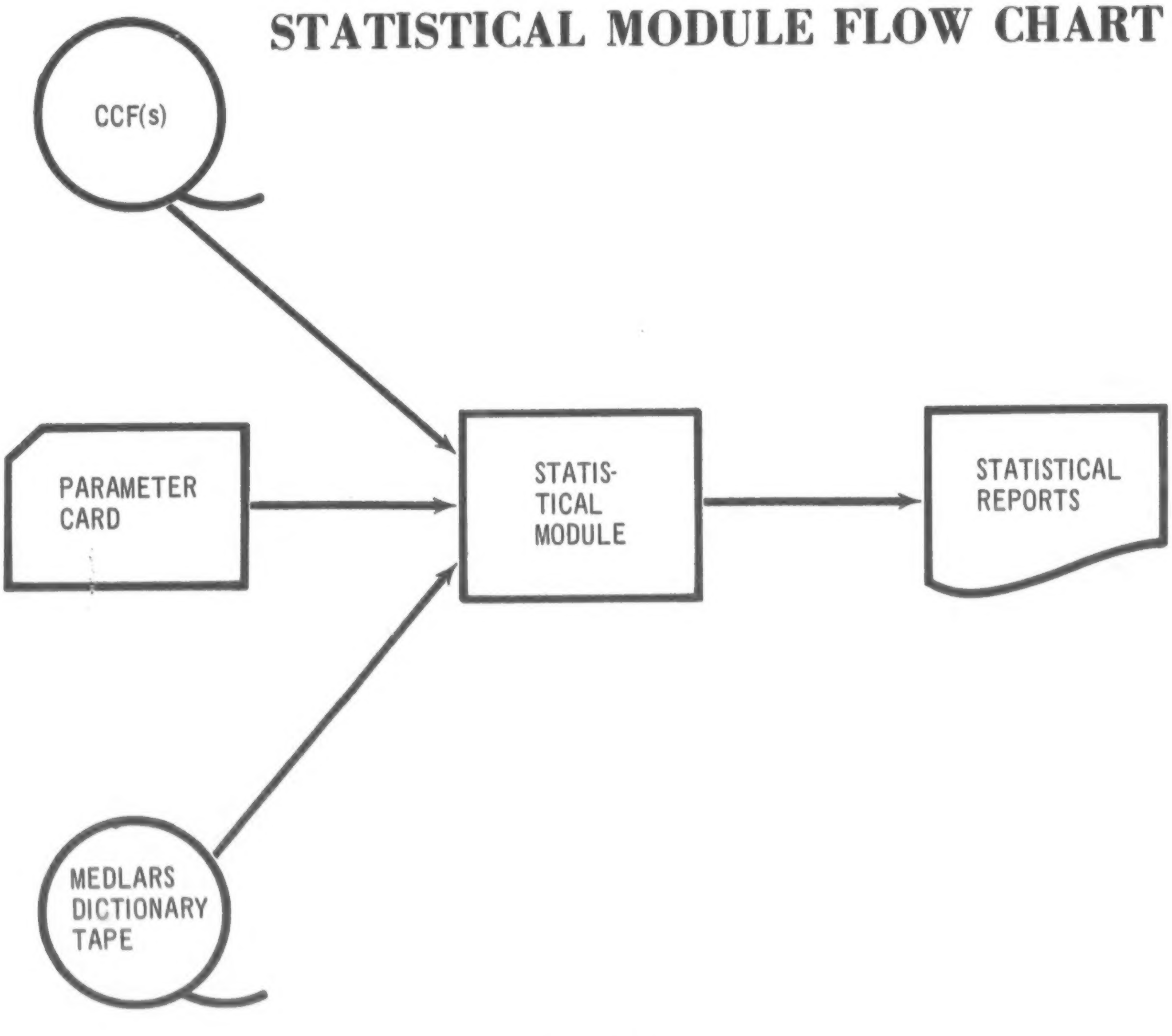

CCF(s)
PARAMETER CARD
STATISTICAL MODULE
STATISTICAL REPORTS
MEDLARS DICTIONARY TAPE

FIGURE 25.

Chapter VII

OPERATING EXPERIENCE: 1963-1967

The preceding chapters have described MEDLARS as it was operating on January 1, 1968. This chapter presents actual operating experience during the period 1963 to 1967, points out differences between the current system and the original design, and comments on how well the original system objectives (listed in Chapter I) have been met.

Data Conversion Period

The initial plan for implementation of MEDLARS called for a one-year data conversion period during the year immediately preceding production (1963). The plan was to build a one-year file of citations on the CCF which would serve two purposes: (1) provide a large data base for final system testing; and (2) provide an initial file of approximately 150,000 citations so that searching could begin immediately after production.

The conversion plan required operation of the new MEDLARS Input Subsystem in parallel with the Listomatic System for production of *Index Medicus*. Three special Flexowriters (paper tape typewriters) were purchased to aid the conversion efforts. Paper tapes produced for the Listomatic System on Justowriter machines were read and copied on the conversion typewriters, with the additional information required for MEDLARS entered from the keyboard.

The conversion plan met with very limited success. Many problems were encountered, the most serious of which are listed below:

(1) Because of delays in computer programming and preparation of the initial MeSH file, the Input Subsystem was not ready for use until April 1963, three months later than planned.

(2) The abnormally high workload created by the need to run parallel systems, coupled with the pressures involved in final testing of the new system, forced the Library to abandon plans for complete conversion and to include only English-language articles in the new system. This fact, along with the delay discussed above, resulted in only 45,000 citations being converted to tape during 1963, rather than the original plan for 150,000.

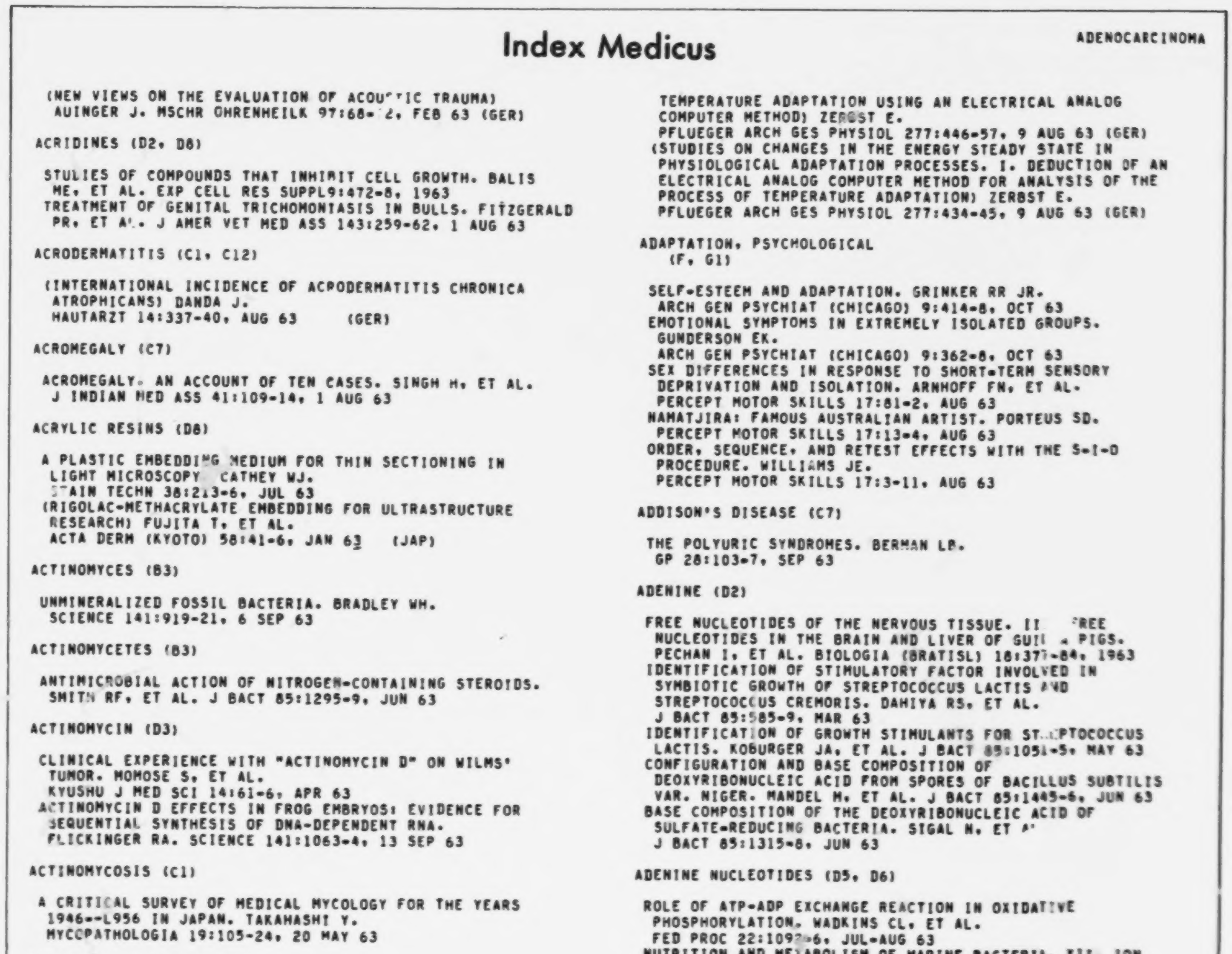
(3) Many "bugs" and inefficiencies in the new Input Subsystem had to be ironed out during the conversion period. Indexing errors occurred because of lack of experience of the indexers with the new system and the requirement for a much greater depth of indexing.

(4) Finally, the deficiencies in the initial MeSH file began to become evident as the conversion and testing period progressed.

Despite these problems, two reels of CCF tape were created and proved invaluable as a resource for final volume testing of the system. These tapes were also used initially for searching. However, the Library decided in 1965 to discontinue searching the conversion file because of indexing inconsistencies and MeSH problems, and these tapes are no longer included in the MEDLARS data base.

Problems with GRACE

GRACE had been scheduled for delivery to NLM in May 1963, well before the operational target date of January 1964. Slippage in the delivery schedule required Library management, late in the summer of 1963, to



Index Medicus

ADENOCARCINOMA

(NEW VIEWS ON THE EVALUATION OF ACOUSTIC TRAUMA) AUINGER J. MSCHR OHRENHEILK 97:68- 2, FEB 63 (GER)

ACRIDINES (D2, D8)

STULIES OF COMPOUNDS THAT INHIRIT CELL GROWTH. BALIS ME, ET AL. EXP CELL RES SUPPL9:472-8, 1963

TREATMENT OF GENITAL TRICHOMONIASIS IN BULLS. FITZGERALD PR, ET AL. J AMER VET MED ASS 143:259-62, 1 AUG 63

ACRODERMATITIS (C1, C12)

(INTERNATIONAL INCIDENCE OF ACRODERMATITIS CHRONICA ATROPHICANS) DANDA J. HAUTARZT 14:337-40, AUG 63 (GER)

ACROMEGALY (C7)

ACROMEGALY. AN ACCOUNT OF TEN CASES. SINGH H, ET AL. J INDIAN MED ASS 41:109-14, 1 AUG 63

ACRYLIC RESINS (D8)

A PLASTIC EMBEDDING MEDIUM FOR THIN SECTIONING IN LIGHT MICROSCOPY. CATHEY WJ. STAIN TECHN 38:213-6, JUL 63

(RIGOLAC-METHACRYLATE EMBEDDING FOR ULTRASTRUCTURE RESEARCH) FUJITA T, ET AL. ACTA DERM (KYOTO) 58:41-6, JAN 63 (JAP)

ACTINOMYCES (B3)

UNMINERALIZED FOSSIL BACTERIA. BRADLEY WH. SCIENCE 141:919-21, 6 SEP 63

ACTINOMYCETES (B3)

ANTIMICROBIAL ACTION OF NITROGEN-CONTAINING STEROIDS. SMITH RF, ET AL. J BACT 85:1295-9, JUN 63

ACTINOMYCIN (D3)

CLINICAL EXPERIENCE WITH "ACTINOMYCIN D" ON WILMS' TUMOR. MOMOSE S, ET AL. KYUSHU J MED SCI 14:61-6, APR 63

ACTINOMYCIN D EFFECTS IN FROG EMBRYOS: EVIDENCE FOR SEQUENTIAL SYNTHESIS OF DNA-DEPENDENT RNA. FLICKINGER RA. SCIENCE 141:1063-4, 13 SEP 63

ACTINOMYCOSIS (C1)

A CRITICAL SURVEY OF MEDICAL MYCOLOGY FOR THE YEARS 1946--L956 IN JAPAN. TAKAHASHI Y. MYCOPATHOLOGIA 19:105-24, 20 MAY 63

ACUTE RENAL FAILURE (C6)

RECOVERY FROM ACUTE RENAL FAILURE AFTER 23 DAYS OF ANURIA. DOUGHERTY JC, ET AL. JAMA 186:68-9, 5 OCT 63

HIGH CARBOHYDRATE INTAKE FOR ORAL USE IN ACUTE RENAL FAILURE. PARSONS FM, ET AL. LANCET 2:386-8, 24 AUG 63

ACUTE RENAL FAILURE. MUIR RD. PROC MINE MED OFFICERS ASS 42:89-95, JAN-APR 63

HEMOLYTIC TRANSFUSION REACTIONS AND ACUTE RENAL FAILURE. BLUEMLE LW JR. TRANS AMER CLIN CLIMAT ASS 74:201-10, 1962

(VASCULAR DAMAGE IN THE BRAIN IN UREMIA) SZEGEDY L. PSYCHIAT NEUROL (BASEL) 146:116-27, 1963 (GER)

(RAPID LABORATORY DIAGNOSIS OF RENAL INSUFFICIENCY IN CLINICAL PRACTICE AND IN THE HOSPITAL) BONITZ K, ET AL. THER GEGENW 102:810-5, JUL 63 (GER)

ADAPTATION, OCULAR (G1)

NEURAL AND PHOTOCHEMICAL MECHANISMS OF VISUAL ADAPTATION IN THE RAT. DOWLING JE. J GEN PHYSIOL 46:1287-301, JUL 63

ADAPTATION, PHYSIOLOGICAL (G1)

THE EFFECTS OF PREANESTHETIC MEDICATION, ANESTHESIA AND HYPOTHERMIA ON THE ENDOCRINE RESPONSE TO INJURY. VAN BRUNT EE, ET AL. ANESTHESIOLOGY 24:500-14, JUL-AUG 63 (7 REF.)

ON THE MECHANISM OF SOME TEMPERATURE EFFECTS ON DROSOPHILA. MILKMAN R. J GEN PHYSIOL 46:1151-70, JUL 63

(STUDIES ON CHANGE IN THE ENERGY STEADY STATE IN PHYSIOLOGICAL ADAPTATION PROCESSES. II. PRINCIPLES FOR QUANTITATIVE EVALUATION OF THE PROCESSES IN TEMPERATURE ADAPTATION USING AN ELECTRICAL ANALOG COMPUTER METHOD) ZERBST E. PFLUEGER ARCH GES PHYSIOL 277:446-57, 9 AUG 63 (GER)

(STUDIES ON CHANGES IN THE ENERGY STEADY STATE IN PHYSIOLOGICAL ADAPTATION PROCESSES. I. DEDUCTION OF AN ELECTRICAL ANALOG COMPUTER METHOD FOR ANALYSIS OF THE PROCESS OF TEMPERATURE ADAPTATION) ZERBST E. PFLUEGER ARCH GES PHYSIOL 277:434-45, 9 AUG 63 (GER)

ADAPTATION, PSYCHOLOGICAL (F, G1)

SELF-ESTEEM AND ADAPTATION. GRINKER RR JR. ARCH GEN PSYCHIAT (CHICAGO) 9:414-8, OCT 63

EMOTIONAL SYMPTOMS IN EXTREMELY ISOLATED GROUPS. GUNDERSON EK. ARCH GEN PSYCHIAT (CHICAGO) 9:362-8, OCT 63

SEX DIFFERENCES IN RESPONSE TO SHORT-TERM SENSORY DEPRIVATION AND ISOLATION. ARNHOFF FN, ET AL. PERCEPT MOTOR SKILLS 17:81-2, AUG 63

NAMATJIRA: FAMOUS AUSTRALIAN ARTIST. PORTEUS SD. PERCEPT MOTOR SKILLS 17:13-4, AUG 63

ORDER, SEQUENCE, AND RETEST EFFECTS WITH THE S-I-D PROCEDURE. WILLIAMS JE. PERCEPT MOTOR SKILLS 17:3-11, AUG 63

ADDISON'S DISEASE (C7)

THE POLYURIC SYNDROMES. BERMAN LB. GP 28:103-7, SEP 63

ADENINE (D2)

FREE NUCLEOTIDES OF THE NERVOUS TISSUE. II. FREE NUCLEOTIDES IN THE BRAIN AND LIVER OF GUINEA PIGS. PECHAN I, ET AL. BIOLOGIA (BRATISL) 18:377-84, 1963

IDENTIFICATION OF STIMULATORY FACTOR INVOLVED IN SYMBIOTIC GROWTH OF STREPTOCOCCUS LACTIS AND STREPTOCOCCUS CREMORIS. DAHIYA RS, ET AL. J BACT 85:585-9, MAR 63

IDENTIFICATION OF GROWTH STIMULANTS FOR STREPTOCOCCUS LACTIS. KOBURGER JA, ET AL. J BACT 85:1051-5, MAY 63

CONFIGURATION AND BASE COMPOSITION OF DEOXYRIBONUCLEIC ACID FROM SPORES OF BACILLUS SUBTILIS VAR. NIGER. MANDEL M, ET AL. J BACT 85:1445-6, JUN 63

BASE COMPOSITION OF THE DEOXYRIBONUCLEIC ACID OF SULFATE-REDUCING BACTERIA. SIGAL N, ET AL. J BACT 85:1315-8, JUN 63

ADENINE NUCLEOTIDES (D5, D6)

ROLE OF ATP-ADP EXCHANGE REACTION IN OXIDATIVE PHOSPHORYLATION. WADKINS CL, ET AL. FED PROC 22:109[illegible]-6, JUL-AUG 63

NUTRITION AND METABOLISM OF MARINE BACTERIA. XII[illegible] ION ACTIVATION OF ADENOSINE TRIPHOSPHATASE IN MEMBRANES OF MARINE BACTERIAL CELLS. DRAPEAU GR, ET AL. J BACT 85:1413-9, JUN 63

CHROMATOGRAPHY ON COMPOUNDS OF BIOLOGICAL INTEREST OF GLASS FIBER, PARAFFIN-COATED, AND UNTREATED CELLULOSE PAPER. EDWARDS CH, ET AL. J CHROMATOGR 11:349-54, JUL 63

(REACTION RATE OF NADP-DEPENDENT OXIDOREDUCTASES IN RAT BRAIN WITH 3-ACETYLPYRIDINE-ADENINE-DINUCLEOTIDE-PHOSPHATE) COPER H, ET AL. J NEUROCHEM 10:513-22, JUL 63 (GER)

(CLINICAL AND EXPERIMENTAL GALACTOSEMIA. BIOCHEMICAL ASPECTS) KORC I. ARCH PEDIAT URUG 34:397-408 CONTD, JUL 63 (SP)

ADENOCARCINOMA (C2)

OBSTRUCTING CARCINOMA WITH ACUTE PROXIMAL ULCERATIVE COLITIS. ADDLEMAN W. AMER J GASTROENT 40:174-8, AUG 63

PRIMARY MALIGNANT NEOPLASMS OF THE DUODENUM: REPORT OF TWELVE CASES. SPINAZZOLA AJ, ET AL. AMER SURG 29:405-12, JUN 63

VASCULAR TREE OF INTRAOCULAR TRANSPLANTS OF FROG RENAL ADENOCARCINOMA. WARNER L. ANGIOLOGY 14:116-20, MAR 63

PERCUTANEOUS TRANSHEPTIC CHOLANGIOGRAPHY AS A DIAGNOSTIC AID IN DISEASES OF THE BILIARY TRACT. HELLENS A VON. ANN CHIR GYNAEC FENN 52:SUPPL121:1-18, 1963

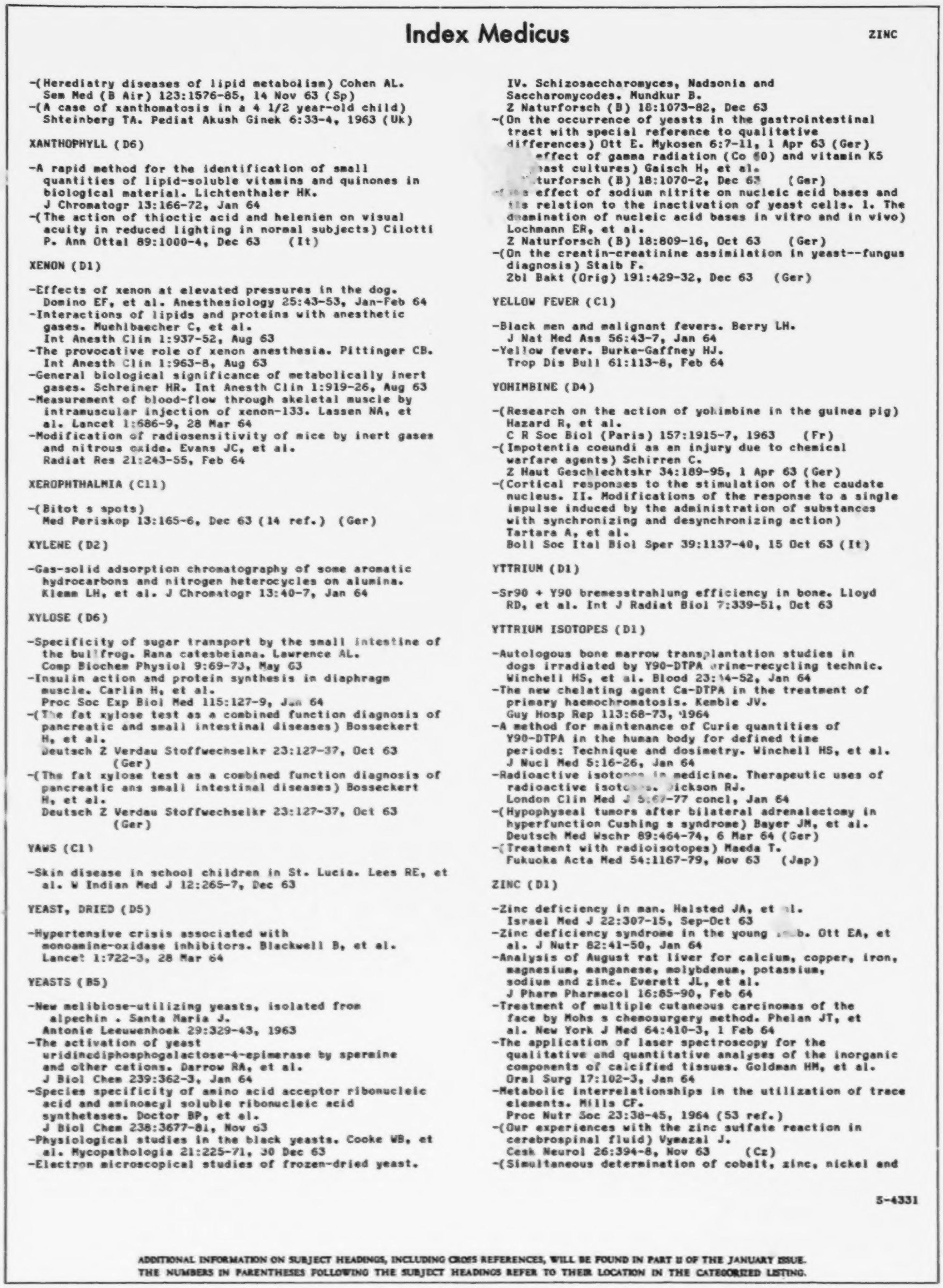
SPONTANEOUS REGRESSION OF PULMONARY METASTASES SECONDARY TO CARCINOMA OF KIDNEY. SAKULA A. BRIT J DIS CHEST 57:147-52, JUL 63

POSTMASTECTOMY LYMPHOSTATIC ENDOTHELIOMA OF STEWART AND TREVES IN A MALE. OETTLE AG, ET AL. BRIT J SURG 50:736-43, JUL 63

S-5

ADDITIONAL INFORMATION ON SUBJECT HEADINGS, INCLUDING CROSS REFERENCES, WILL BE FOUND IN PART II OF THE JANUARY ISSUE.
THE NUMBERS IN PARENTHESES FOLLOWING THE SUBJECT HEADINGS REFER TO THEIR LOCATION IN THE CATEGORIZED LISTING.

FIGURE 26.—*Specimen Page of Jan. 1964* Index Medicus, *Produced on Honeywell Computer Printer.*



Index Medicus

ZINC

-(Herediatry diseases of lipid metabolism) Cohen AL. Sem Med (B Air) 123:1576-85, 14 Nov 63 (Sp)

-(A case of xanthomatosis in a 4 1/2 year-old child) Shteinberg TA. Pediat Akush Ginek 6:33-4, 1963 (Uk)

XANTHOPHYLL (D6)

-A rapid method for the identification of small quantities of lipid-soluble vitamins and quinones in biological material. Lichtenthaler HK. J Chromatogr 13:166-72, Jan 64

-(The action of thioctic acid and helenien on visual acuity in reduced lighting in normal subjects) Cilotti P. Ann Ottal 89:1000-4, Dec 63 (It)

XENON (D1)

-Effects of xenon at elevated pressures in the dog. Domino EF, et al. Anesthesiology 25:43-53, Jan-Feb 64

-Interactions of lipids and proteins with anesthetic gases. Muehlbaecher C, et al. Int Anesth Clin 1:937-52, Aug 63

-The provocative role of xenon anesthesia. Pittinger CB. Int Anesth Clin 1:963-8, Aug 63

-General biological significance of metabolically inert gases. Schreiner HR. Int Anesth Clin 1:919-26, Aug 63

-Measurement of blood-flow through skeletal muscle by intramuscular injection of xenon-133. Lassen NA, et al. Lancet 1:686-9, 28 Mar 64

-Modification of radiosensitivity of mice by inert gases and nitrous oxide. Evans JC, et al. Radiat Res 21:243-55, Feb 64

XEROPHTHALMIA (C11)

-(Bitot s spots) Med Periskop 13:165-6, Dec 63 (14 ref.) (Ger)

XYLENE (D2)

-Gas-solid adsorption chromatography of some aromatic hydrocarbons and nitrogen heterocycles on alumina. Klemm LH, et al. J Chromatogr 13:40-7, Jan 64

XYLOSE (D6)

-Specificity of sugar transport by the small intestine of the bullfrog. Rana catesbeiana. Lawrence AL. Comp Biochem Physiol 9:69-73, May 63

-Insulin action and protein synthesis in diaphragm muscle. Carlin H, et al. Proc Soc Exp Biol Med 115:127-9, Jan 64

-(The fat xylose test as a combined function diagnosis of pancreatic and small intestinal diseases) Bosseckert H, et al. Deutsch Z Verdau Stoffwechselkr 23:127-37, Oct 63 (Ger)

-(The fat xylose test as a combined function diagnosis of pancreatic ans small intestinal diseases) Bosseckert H, et al. Deutsch Z Verdau Stoffwechselkr 23:127-37, Oct 63 (Ger)

YAWS (C1)

-Skin disease in school children in St. Lucia. Lees RE, et al. W Indian Med J 12:265-7, Dec 63

YEAST, DRIED (D5)

-Hypertensive crisis associated with monoamine-oxidase inhibitors. Blackwell B, et al. Lancet 1:722-3, 28 Mar 64

YEASTS (B5)

-New melibiose-utilizing yeasts, isolated from alpechin . Santa Maria J. Antonie Leeuwenhoek 29:329-43, 1963

-The activation of yeast uridinediphosphogalactose-4-epimerase by spermine and other cations. Darrow RA, et al. J Biol Chem 239:362-3, Jan 64

-Species specificity of amino acid acceptor ribonucleic acid and aminoacyl soluble ribonucleic acid synthetases. Doctor BP, et al. J Biol Chem 238:3677-81, Nov 63

-Physiological studies in the black yeasts. Cooke WB, et al. Mycopathologia 21:225-71, 30 Dec 63

-Electron microscopical studies of frozen-dried yeast. IV. Schizosaccharomyces, Nadsonia and Saccharomycodes. Mundkur B. Z Naturforsch (B) 18:1073-82, Dec 63

-(On the occurrence of yeasts in the gastrointestinal tract with special reference to qualitative differences) Ott E. Mykosen 6:7-11, 1 Apr 63 (Ger)

-(The effect of gamma radiation (Co 60) and vitamin K5 on yeast cultures) Gaisch H, et al. Z Naturforsch (B) 18:1070-2, Dec 63 (Ger)

-(The effect of sodium nitrite on nucleic acid bases and its relation to the inactivation of yeast cells. 1. The deamination of nucleic acid bases in vitro and in vivo) Lochmann ER, et al. Z Naturforsch (B) 18:809-16, Oct 63 (Ger)

-(On the creatin-creatinine assimilation in yeast--fungus diagnosis) Staib F. Zbl Bakt (Orig) 191:429-32, Dec 63 (Ger)

YELLOW FEVER (C1)

-Black men and malignant fevers. Berry LH. J Nat Med Ass 56:43-7, Jan 64

-Yellow fever. Burke-Gaffney HJ. Trop Dis Bull 61:113-8, Feb 64

YOHIMBINE (D4)

-(Research on the action of yohimbine in the guinea pig) Hazard R, et al. C R Soc Biol (Paris) 157:1915-7, 1963 (Fr)

-(Impotentia coeundi as an injury due to chemical warfare agents) Schirren C. Z Haut Geschlechtskr 34:189-95, 1 Apr 63 (Ger)

-(Cortical responses to the stimulation of the caudate nucleus. II. Modifications of the response to a single impulse induced by the administration of substances with synchronizing and desynchronizing action) Tartara A, et al. Boll Soc Ital Biol Sper 39:1137-40, 15 Oct 63 (It)

YTTRIUM (D1)

-Sr90 + Y90 bremesstrahlung efficiency in bone. Lloyd RD, et al. Int J Radiat Biol 7:339-51, Oct 63

YTTRIUM ISOTOPES (D1)

-Autologous bone marrow transplantation studies in dogs irradiated by Y90-DTPA urine-recycling technic. Winchell HS, et al. Blood 23:[illegible]4-52, Jan 64

-The new chelating agent Ca-DTPA in the treatment of primary haemochromatosis. Kemble JV. Guy Hosp Rep 113:68-73, 1964

-A method for maintenance of Curie quantities of Y90-DTPA in the human body for defined time periods: Technique and dosimetry. Winchell HS, et al. J Nucl Med 5:16-26, Jan 64

-Radioactive isotopes in medicine. Therapeutic uses of radioactive isotopes. Dickson RJ. London Clin Med J 5:67-77 concl, Jan 64

-(Hypophyseal tumors after bilateral adrenalectomy in hyperfunction Cushing s syndrome) Bayer JM, et al. Deutsch Med Wschr 89:464-74, 6 Mar 64 (Ger)

-(Treatment with radioisotopes) Maeda T. Fukuoka Acta Med 54:1167-79, Nov 63 (Jap)

ZINC (D1)

-Zinc deficiency in man. Halsted JA, et al. Israel Med J 22:307-15, Sep-Oct 63

-Zinc deficiency syndrome in the young lamb. Ott EA, et al. J Nutr 82:41-50, Jan 64

-Analysis of August rat liver for calcium, copper, iron, magnesium, manganese, molybdenum, potassium, sodium and zinc. Everett JL, et al. J Pharm Pharmacol 16:85-90, Feb 64

-Treatment of multiple cutaneous carcinomas of the face by Mohs s chemosurgery method. Phelan JT, et al. New York J Med 64:410-3, 1 Feb 64

-The application of laser spectroscopy for the qualitative and quantitative analyses of the inorganic components of calcified tissues. Goldman HM, et al. Oral Surg 17:102-3, Jan 64

-Metabolic interrelationships in the utilization of trace elements. Mills CF. Proc Nutr Soc 23:38-45, 1964 (53 ref.)

-(Our experiences with the zinc sulfate reaction in cerebrospinal fluid) Vymazal J. Cesk Neurol 26:394-8, Nov 63 (Cz)

-(Simultaneous determination of cobalt, zinc, nickel and

5-4331

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THE NUMBERS IN PARENTHESES FOLLOWING THE SUBJECT HEADINGS REFER TO THEIR LOCATION IN THE CATEGORIZED LISTING.

FIGURE 27.—*Specimen Page of July 1964* Index Medicus, *Produced on IBM 1403 Printer.*

face a major decision: delay the inauguration of MEDLARS or find an alternate way to print *Index Medicus*.

A decision was made to follow the original production schedule, and a crash programming effort resulted in a set of programs to print *Index Medicus* on the standard computer printer with a very limited character set of uppercase symbols only, using the same tapes (EPCF) for input that would have been used to produce GRACE copy. This procedure was used for six issues, January to June 1964 (see Figure 26).

During the first part of 1964, these print programs were modified to create a tape for printing on an IBM-1403 Chain Printer at a private company in Washington, D.C. This printer was capable of producing both upper- and lowercase letters and the July 1964 issue was produced by this method (see Figure 27).

One year late, GRACE finally arrived at NLM in May 1964 and, after careful checkout, was used for production of *Index Medicus* beginning with the August 1964 issue. The decision to begin production in January 1964 proved to be a good one, since the EPCF's for the first seven issues produced by the computer printer were available for use in producing the *Cumulated Index Medicus* for 1964 by GRACE. *Note:* Refer back to Figure 21 to compare GRACE page with Honeywell and IBM printout.

Initial Production Period

As described above, MEDLARS became operational in January 1964. Transition to the new system was effected without great difficulty, a testimony to the joint efforts of the contractor and NLM staff in system testing and training of personnel. Contractor personnel (except those working on GRACE) were able to leave the Library in February 1964 and no system maintenance contracts were required.

Computer programs of the Input and Publication Subsystems seemed to work much more effectively during the initial year of production than did the Demand Search Programs. Many program "bugs" continued to appear in the search routines. These problems, coupled with problems in the conversion CCF file described earlier, resulted in poor demand search production in 1964.

Some of the major deficiencies in the MeSH vocabulary were discovered in 1964. The Library began to realize that outside expert advice was needed for improving the vocabulary, and major revisions were made for 1965. Other problems were encountered in smoothing out operating procedures; such things as error and rejection rates of input citations were found to have been underestimated.

Maintenance of the System; Changes Made

No system design is ever perfect; and no good manager will be content to have a system remain static without constant improvements and changes being made. MEDLARS is no exception to this rule. Many problems encountered during operation have resulted in changes from the original design. Some of the more important changes are listed below:

(1) *Input Errors.* The high number of errors in citations entering the system pointed up the need for additional input editing. As a result, a new procedure was installed to print all new citations added to the CCF each day and have these proofread by an experienced editor.

(2) *Change of Recurring Bibliography Procedures.* The original input programs created both a CCF and PCF (Processed Citation File). Selection and formatting of citations for recurring bibliographies was done by the Input Module, and the PCF was used directly in the Publication Subsystem. This approach was believed to be efficient in that it leveled out the output workload by doing it every day. However, in actual practice, this method turned out to be very inefficient because of the long Input Module runs that resulted. In 1966 the Library converted to a single file system (CCF) and used the Demand Search Programs to select citations for recurring bibliographies. The result was a net saving of over fifty hours per month of computer time.

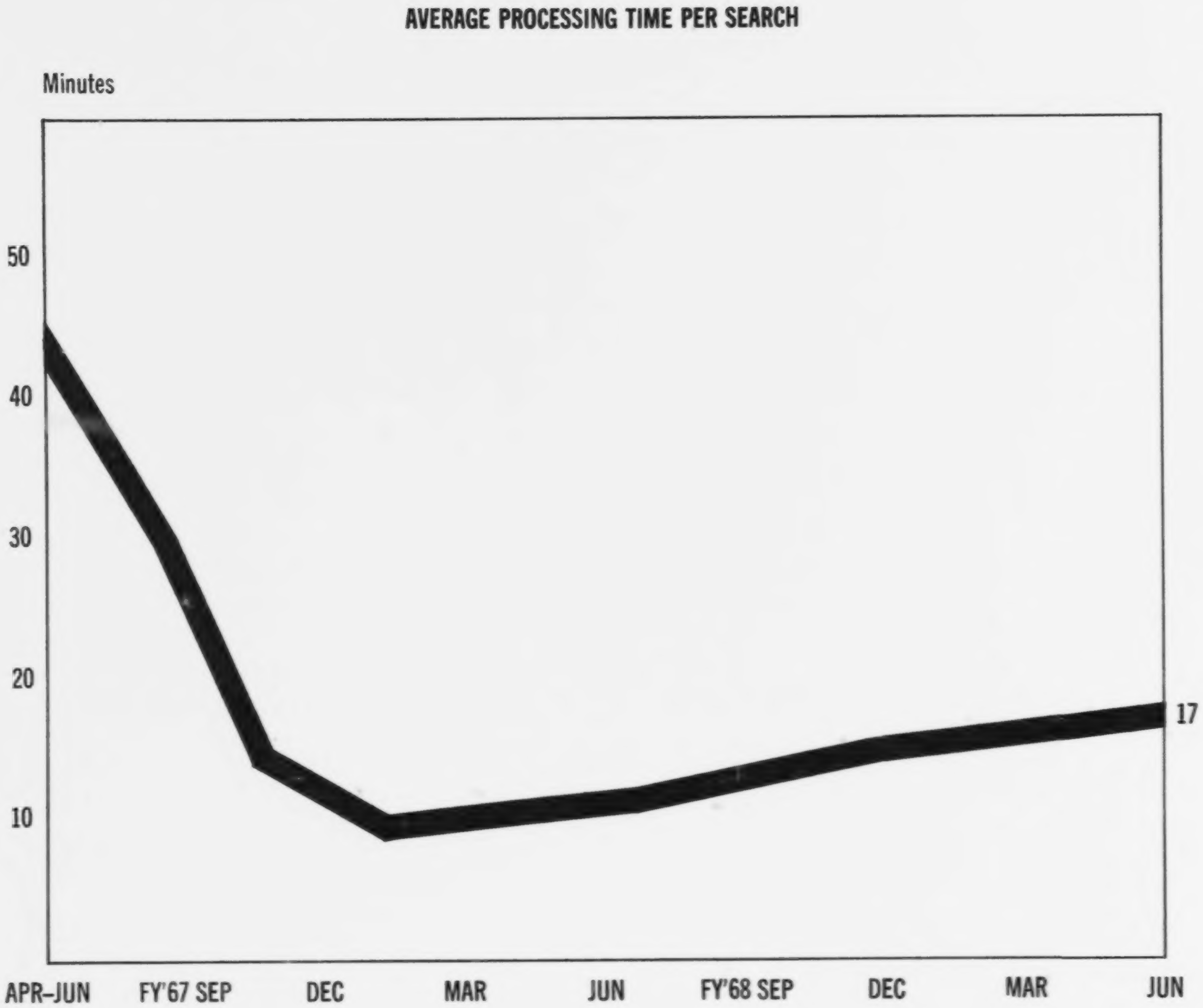
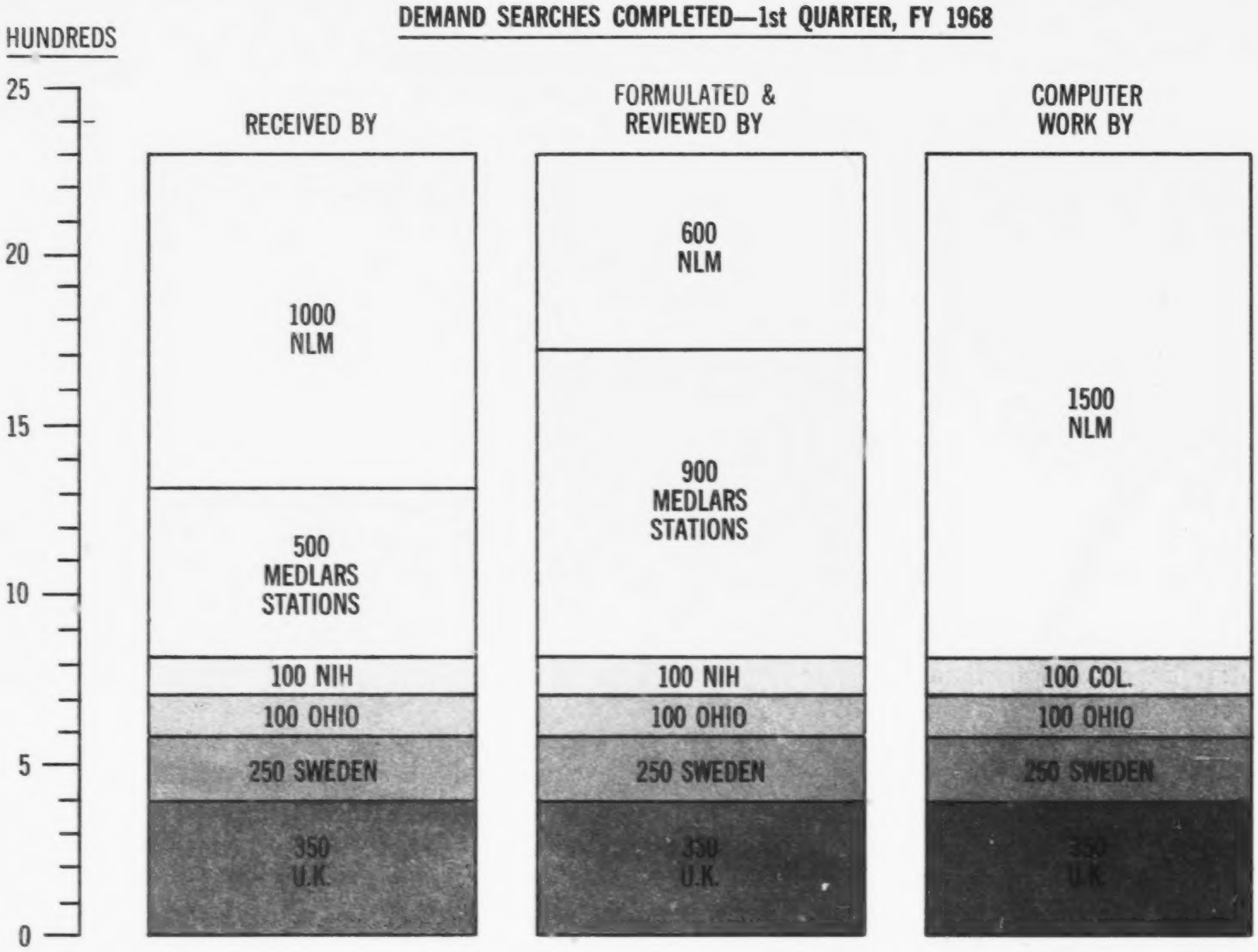


Figure 28.

(3) *Demand Search Problems.* High rejection rates for demand searches along with slow turnaround times caused many changes to be made in the Retrieval Subsystem. Conversion from complete paper tape punching of all search formulations to use of prepunched MeSH cards (see Chapter IV) improved the error and rejection problem. Major changes in the Demand Search Programs resulted in an increase of average batch size from about ten searches per batch to as many as 60, with the average between 25 and 30. The computer processing time for a search was reduced to about 30% of its previous length. Figure 28 is a chart showing the improvements in search processing time over the years. Procedural changes have also helped to improve turnaround time somewhat.

(4) *File Maintenance.* Many inefficiencies were discovered in the File Maintenance Module. Perhaps the most serious was the inability of these programs to handle mass changes in the tree structures (hierarchy of terms) of MeSH. Modification of the module to add this feature resulted in a 9–to–1 improvement in computer time, and, perhaps more important, a reduction of months of clerical effort previously required to change individual citations.



DEMAND SEARCHES COMPLETED—1st QUARTER, FY 1968

FIGURE 29.

(5) *MeSH Revision.* The original system design for MEDLARS grossly underestimated the size and number of changes to MeSH that would be required for the annual revision. New procedures had to be developed, with utility programs written to aid the staff of the MeSH Section. Over 500 new terms have been added for the 1968 revision.

Other changes are still required and system maintenance will be an on-going process. The NLM programming staff must constantly plan on system maintenance as a major factor in estimating workloads.

MEDLARS Decentralization

Decentralization of the MEDLARS Retrieval Subsystem was planned during the original systems design period. The major objectives of the decentralization program were: (1) improve demand search service by providing regional service closer to users throughout the country; and (2) increase the total number of searches processed each year by the use of multiple search stations.

Consideration was given to several alternate approaches to decentralization, including: (1) decentralize the search formulation activities, but continue centralized computer processing at NLM, and submit searches via data communication equipment; (2) establish regional offices of NLM with both searchers and their own computer equipment for search processing; and (3) contract with existing centers to provide search services on a regional basis. After much study, the last was selected, since it would bring the service closer to the user, and, at the same time, bolster local medical library resources. The original plans thus developed called for contracts to be awarded to from six to ten universities or other nonprofit organizations with a combination of good medical library and computer resources.

Two contracts were awarded in 1965—one with the University of Colorado to serve the Mountain Time Zone, and another with the University of California at Los Angeles to serve the Far West. The Colorado MEDLARS staff contracted for time on a Honeywell-800 computer at the Denver Federal Center, and, since no major reprogramming was needed, was able to become operational in short order. The Colorado Station has been running searches since February 1965.

The UCLA contract was more complex. Computer processing was to be done on an IBM 7094–7040 direct coupled computer system. Since complete reprogramming of the Demand Search and Report Generator Modules was required, the Library directed that these programs be rewritten in COBOL, a machine-independent language which could be used on other makes and models of computers. This decision turned out to be a mistake, at least in part. Since the COBOL language is necessarily generalized, it does not generate the most efficient operating programs. The combined high-speed logical search program took so much computer time that it had to be rewritten in a machine-oriented language. Unfortunately, the MEDLARS computer system at UCLA has never become operational. Delays encountered in reprogramming and the replacement of the 7094 computer by an IBM-360/75 before the project was completed caused NLM staff to change plans and process UCLA MEDLARS searches on the central computer in Bethesda.

Contracts were awarded in 1966 to Harvard University, the University of Alabama, and the University of Michigan for development of additional MEDLARS Stations, bringing the total to five. The Stations have sent personnel to NLM for six months of intensive training in indexing, MeSH, and search formulation. All five Stations are now formulating searches. However, because of reprogramming problems, only the Colorado Station was actually processing searches as of January 1, 1968—the other Stations mailing formulated searches to Bethesda. Some of the reasons for this are discussed below.

In addition to the five regional MEDLARS Stations, Ohio State University and the Texas Medical Center in Houston asked for access to the MEDLARS tapes in order to establish stations with their own resources. Ohio State, which has two IBM-7094 systems, completed debugging of the UCLA MEDLARS Program, made some modifications, and now has the system operational. Ohio State was recently designated as MEDLARS Search Station for the State of Ohio, and the Texas Medical Center is now operating privately without financial support from NLM.

MEDLARS decentralization has also taken place internationally. The United Kingdom is now operating a MEDLARS Station for all of Great Britain. Searches are formulated at the National Lending Library for Science and Technology, and computer processing is handled at the University of Newcastle-upon-Tyne. Complete reprogramming of the search routines was successfully accomplished for the English Electric KDF–9 computer.* A second international MEDLARS Station is in successful operation at the Karolinska Institut in Stockholm, Sweden. Searches at this Station are processed on a system utilizing an IBM-1401 and IBM-7094 computer.

Figure 29 is a graph showing searches produced during one three-month period through the MEDLARS Decentralization Program. Plans have also been made to include MEDLARS Search Stations at all Regional Medical Libraries to be established under the provisions of the Medical Library Assistance Act of 1965.

It is obvious from the above discussion that the MEDLARS Decentralization Program has had many problems. Some of these are summarized below:

(1) *Reprogramming Problems.* The time and effort involved was badly underestimated by NLM staff.

(2) *Tape Conversion Problems.* The prob-

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*A. J. Harley and E. D. Barraclough, MEDLARS Information Retrieval in Britain, *The Postgraduate Medical Journal,* London, Feb. 1966.

lem of converting from one magnetic tape format to another was thought to be trivial, but this was not so. Many problems were encountered; for example, a missing designator indicating the end of a data field on a tape generated by NLM causes havoc with the Tape Conversion Program at a MEDLARS Station.

(3) *Difficulties Encountered at University Computer Stations.* Most university centers have not had experience with the operation of large-file data processing systems. They are more accustomed to running short computational problems. One Station didn't even realize that it had a defective magnetic tape drive which was stretching tapes until it started MEDLARS processing. Similar problems were encountered in programming and software development.

(4) *Communications Problems.* Because of the remote location of the MEDLARS Stations, communications between NLM and regional personnel were not always as good as they should have been. The coordination and training of searchers turned out quite well, however.

(5) Because of the above, developmental time and costs for the Stations were higher than originally anticipated.

Formal Evaluation of MEDLARS

A comprehensive project to evaluate the demand search performance of MEDLARS was initiated in January 1966—two years after operation began. A preliminary test was conducted early that year to establish the feasibility of approach, and the full test program became operational in August 1966. The evaluation was completed in December 1967, and the final report will be published in 1968. An advisory committee of six experts in the fields of documentation, statistics, information retrieval, and computer science provided a critical review of the study as it progressed.*

Twenty organizations, representing the principal types of medical groups (academic, clinical, research, pharmaceutical, regulatory) making use of MEDLARS, cooperated in the study. The majority of the demand search requests made by members of these organizations within a 12-month period were treated as test requests. These were all "real-life" requests, representing actual information needs. While the organizations agreed in advance to cooperate in the study, the individual requester knew nothing of the evaluation until his request had been made to the system.

The test program was conducted to determine how well MEDLARS retrievals are satisfying the demands of users and, in addition, what factors are the principal contributors to system failures. Data derived from the test program are of two types: (1) performance figures and (2) case studies.

Performance figures include *recall ratios* (the proportion of the total of relevant articles, contained in the data base, that is retrieved in a search), *precision ratios* (the proportion of all articles returned in a search that are judged relevant), and *novelty ratios* (the proportion of the relevant articles retrieved that are brought to the requester's attention for the first time by the MEDLARS search). Recall and precision ratios are used to compare the performance of the system in various modes and conditions of operation. For example, they allow a comparison of performance for various kinds of user groups, for various kinds of requests (across broad subject fields), and for requests handled with varying levels of user-system interaction.

Case studies are analyses of system failures (i.e., failures to retrieve known relevant articles, or instances in which large numbers of irrelevant citations were retrieved). An analysis is conducted to determine at what point the system failed.

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*F. W. Lancaster, Evaluating the Performance of a Large Operating Retrieval System, *Proceedings of the Second Electronic Information Handling Conference*, Thompson Book Co., Washington, D.C., 1967.

The evaluation program is diagnostic, intended to identify major problem areas, and thus allows appropriate corrective action in system design and operating procedures.

The study revealed that MEDLARS is operating, on the average, at about 58% recall and 50% precision. Thus, the system retrieves about 58% of all the references in the system which would be of value to the requester, and one out of every two documents retrieved is judged to be of value by the requester. The study further showed considerable scatter of results, indicating wide variation of performance among the test searches.

Of considerably more importance than these figures are the reasons for system failures. Each system failure was extensively analyzed and attributed to the indexing, indexing language, user-system interaction, searching strategies employed, computer processing, or a combination of the above. The results of this analysis, based on the results from 300 test searches, are listed in Table 7. Further discussion of this analysis can be found in the final report of the MEDLARS evaluation project.*

Table 7

Failure Analysis Table

Failure Attributed To:	*Number of Recall Failures*	*Number of Precision Failures*
Indexing	298	393
Indexing Language	81	1094
Inadequate User-System Interaction	199	503
Searching Strategies	279	983
Computer Processing	11	3

Performance in Relation to Original System Objectives

To summarize this chapter on operating experience, the original system objectives of MEDLARS (as listed in Chapter I) are reexamined to see how well they have been met and what changes in goals were required:

Objective No. 1:
Improve the quality of and enlarge (broaden the scope of) Index Medicus *and at the same time reduce the time required to prepare the monthly editions for printing from 22 to 5 workdays.*

Comment: For the most part, this objective has been met. The quality of *Index Medicus* has been improved through improvements to MeSH, improvements in the journal selection process, and constant attention to indexing accuracy. The scope has been broadened considerably from 129,808 articles from 2,275 journal titles in 1963 to 163,077 articles from 2300 journal titles in 1967. Processing time has been cut to about five days.

Objective No. 2:
Make possible the production of other compilations similar to Index Medicus *in form and content (but in more specific medical subject areas and hence smaller in size).*

Comment: This objective has been accomplished through the production of recurring bibliographies (see Table 1, Chapter II). However, the original estimate of 50 recurring bibliographies was too high and only nine were in production on January 1, 1968, with some others in the planning stage. Because of the difficulties in the intellectual effort required, the development of recurring bibliographies turned out to be a much larger job than was originally estimated.

Objective No. 3:
Make it possible to include in Index Medicus *and other compilations citations derived, not only from journal articles, but from other sources as well.*

Comment: The system capability to include citations to monographs in MEDLARS was provided through reprogramming for the *Current Catalog* (see Chapter VIII).

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*F. W. Lancaster, *Evaluation of the MEDLARS Demand Search Service*, National Library of Medicine, Bethesda, Maryland, 1968.

Objective No. 4:
Make possible the prompt (a maximum of two days) and efficient servicing of requests for special bibliographies, on both a demand and a recurring basis, regularly searching up to five years of stored computer files.

Comment: It has not been possible to accomplish a two-day search turnaround time with the present batch processing system. Also, because of computer time limitation, demand searches beginning in early 1968 include only references from January 1966 on, instead of references from the entire file.

Objective No. 5:
Increase the average depth of indexing per article (number of descriptive subject terms per article) by a factor of five, i.e., ten headings versus two.

Comment: This objective has been accomplished for depth journals to which an average of about ten subject headings per article are assigned (see Chapter III). However, non-depth journals are indexed to an average depth of only about four terms.

Objective No. 6:
Nearly double the number of articles that may be handled (indexed and entered into the computer) annually—from 140,000 now to 250,000 in 1969.

Comment: Production has increased with MEDLARS to 165,000 articles input in 1967. Library management hopes to meet the goal of 250,000 articles by 1969, but the attainment of this goal remains uncertain.

Objective No. 7:
Reduce the need for duplicative total literature screening operations (at other libraries and information centers).

Comment: This objective is difficult to evaluate. However, all indications point to its being met. *Index Medicus* and other MEDLARS bibliographies are used extensively in libraries and information centers as literature screening tools. No other medical indexing operation comparable in size to MEDLARS has come into existence. Hence, it can reasonably be assumed that a good deal of expensive, duplicative indexing has been avoided.

Objective No. 8:
Keep statistics and perform analyses of its own operations to provide the information needed to monitor and improve system effectiveness.

Comment: This objective has been partially accomplished through the Statistical Module Reports described in Chapter VI. Other reports have been identified that could be derived from the system and could be very useful (e.g., statistical data on demand searches). However, for the most part, NLM programmers have been too busy to work on these reports.

Objective No. 9:
Permit future expansion to incorporate new and as yet not completely defined—hence, secondary—objectives.

Comment: This objective has been accomplished. Installation of MEDLARS has provided a base of data processing equipment and experienced system personnel at the Library for work on new systems and extensions of MEDLARS. Chapter VIII describes a major new system, derived from MEDLARS, which has been in production since January 1966.

Of the nine original objectives of MEDLARS, three have been completely accomplished, six partly accomplished.

Chapter VIII

THE *CURRENT CATALOG*—AN EXTENSION OF MEDLARS

Background and History*

The original plan for MEDLARS called for entry of cataloging data for all new monographs, theses, and serial titles into the computer files. Citations representing this cataloging were to appear in *Index Medicus*, which would constitute the only book-form record of the NLM catalog. This plan was subsequently abandoned for several reasons. First, systems limitations in MEDLARS would not permit the publishing of citations in acceptable form without extensive modifications. Second, the books and serial titles are not assigned subject headings in sufficient depth to be effectively mixed with the more detailed indexing of journal articles. Third, a re-examination of the potential uses of a book-form catalog pointed up possible advantages to other medical libraries in a separate book-form catalog printed at frequent intervals.

For these reasons, the original plan was dropped, and, in February 1964, a systems analyst began work on a new computer-aided catalog processing system. This system represents the first major extension of MEDLARS, taking further advantage of the experienced data processing staff and equipment acquired to operate MEDLARS. No outside contract help was used in the design or implementation of the cataloging system.

Design work lasted for about one year and programming began early in 1965. Rather than writing all new programs, the new system relied heavily on modifications to the MEDLARS Input and Output Modules to incorporate new requirements. System tests were run during November and December of 1965, and the new system went into production, on schedule, in January 1966.

The major objectives of this system are (1) to make NLM cataloging available to other medical libraries on a current and frequent basis for use as an acquisitions and cataloging tool, and (2) to improve the internal production of cards for the central NLM card catalog.

Products of the System

The cataloging system produces two major products: the *NLM Current Catalog* and catalog cards.

The *NLM Current Catalog* (see Figure 30) is computer-produced and published biweekly and quarterly. The biweekly issues contain citations to publications cataloged by the Library which have recent imprint dates. The quarterly issues are cumulative and contain all citations cataloged from January of the current year, regardless of imprint date. The final quarterly cumulation of the year is hardbound and serves as the permanent record of that year's cataloging.

Both biweekly and quarterly issues contain a Subject Section, with citations listed alphabetically by main entry under subject headings. Subheadings are used in the quarterly issues only. All issues also contain a Name Section, an alphabetic author/title listing of citations. Citations appear in full only under the main entry and cross-references appear only in the quarterly issues. Library of Congress card numbers, when available, are included with the citation.

The second product of the system is the catalog card. Complete 3″ x 5″ catalog card

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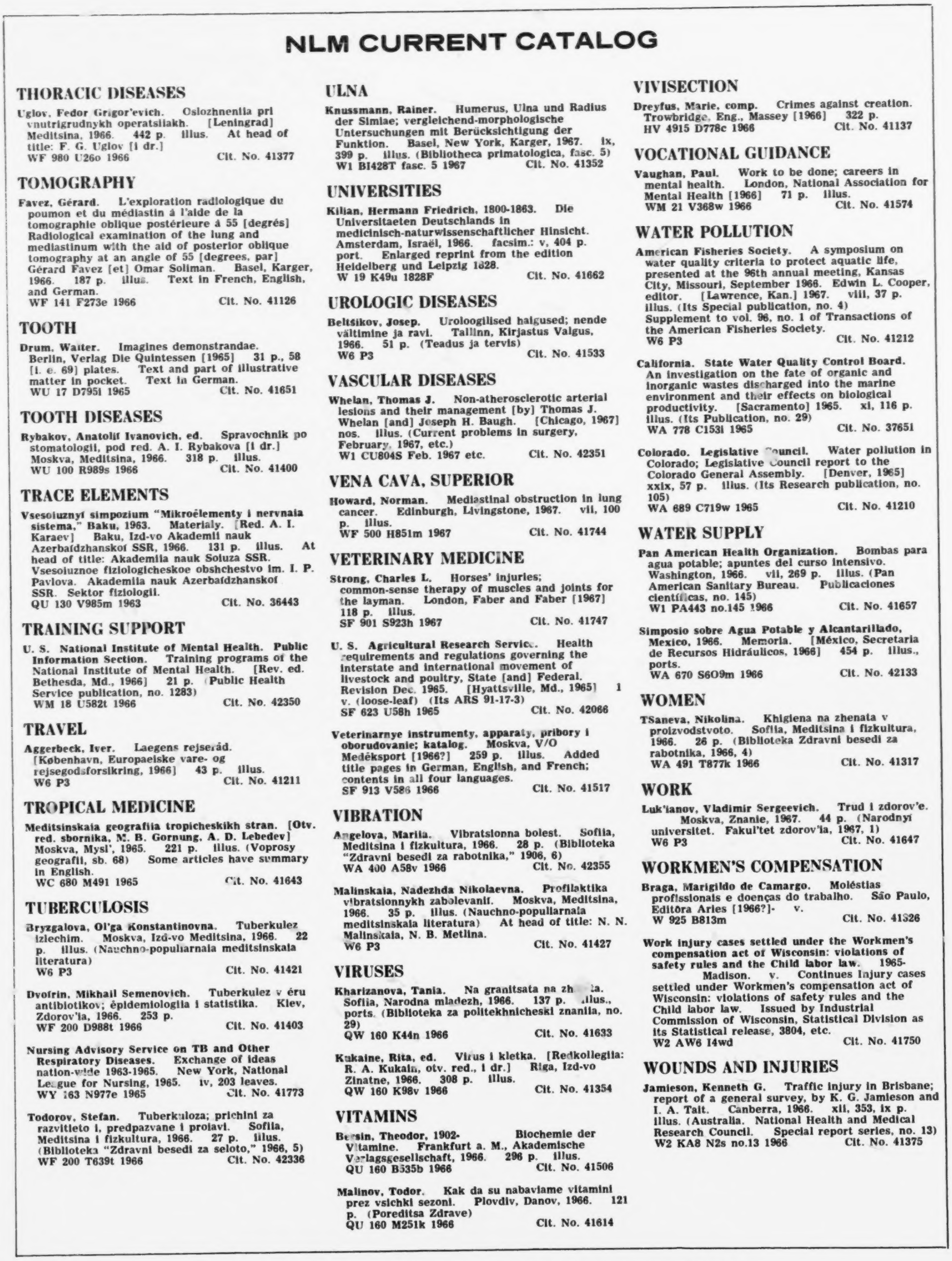
*For a more detailed description of this system see: I. J. Weiss and E. V. Wiggins, Computer-Aided Centralized Cataloging at the National Library of Medicine, *Library Resources and Technical Services*, Vol. 11, No. 1, Winter 1967.



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THORACIC DISEASES

Uglov, Fedor Grigor'evich. Oslozhneniia pri vnutrigrudnykh operatsiiakh. [Leningrad] Meditsina, 1966. 442 p. illus. At head of title: F. G. Uglov [i dr.]
WF 980 U26o 1966 Cit. No. 41377

TOMOGRAPHY

Favez, Gérard. L'exploration radiologique du poumon et du médiastin à l'aide de la tomographie oblique postérieure à 55 [degrés] Radiological examination of the lung and mediastinum with the aid of posterior oblique tomography at an angle of 55 [degrees, par] Gérard Favez [et] Omar Soliman. Basel, Karger, 1966. 187 p. illus. Text in French, English, and German.
WF 141 F273e 1966 Cit. No. 41126

TOOTH

Drum, Walter. Imagines demonstrandae. Berlin, Verlag Die Quintessen [1965] 31 p., 58 [i. e. 69] plates. Text and part of illustrative matter in pocket. Text in German.
WU 17 D795i 1965 Cit. No. 41651

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Rybakov, Anatoliĭ Ivanovich, ed. Spravochnik po stomatologii, pod red. A. I. Rybakova [i dr.] Moskva, Meditsina, 1966. 318 p. illus.
WU 100 R989s 1966 Cit. No. 41400

TRACE ELEMENTS

Vsesoiuznyĭ simpozium "Mikroélementy i nervnaia sistema," Baku, 1963. Materialy. [Red. A. I. Karaev] Baku, Izd-vo Akademii nauk Azerbaĭdzhanskoĭ SSR, 1966. 131 p. illus. At head of title: Akademiia nauk Soiuza SSR. Vsesoiuznoe fiziologicheskoe obshchestvo im. I. P. Pavlova. Akademiia nauk Azerbaĭdzhanskoĭ SSR. Sektor fiziologii.
QU 130 V985m 1963 Cit. No. 36443

TRAINING SUPPORT

U. S. National Institute of Mental Health. Public Information Section. Training programs of the National Institute of Mental Health. [Rev. ed. Bethesda, Md., 1966] 21 p. (Public Health Service publication, no. 1283)
WM 18 U582t 1966 Cit. No. 42350

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Aggerbeck, Iver. Laegens rejseråd. [København, Europaeiske vare- og rejsegodsforsikring, 1966] 43 p. illus.
W6 P3 Cit. No. 41211

TROPICAL MEDICINE

Meditsinskaia geografiia tropicheskikh stran. [Otv. red. sbornika, M. B. Gornung, A. D. Lebedev] Moskva, Mysl', 1965. 221 p. illus. (Voprosy geografii, sb. 68) Some articles have summary in English.
WC 680 M491 1965 Cit. No. 41643

TUBERCULOSIS

Bryzgalova, Ol'ga Konstantinovna. Tuberkulez izlechim. Moskva, Izd-vo Meditsina, 1966. 22 p. illus. (Nauchno-populiarnaia meditsinskaia literatura)
W6 P3 Cit. No. 41421

Dvoĭrin, Mikhail Semenovich. Tuberkulez v ėru antibiotikov; ėpidemiologiia i statistika. Kiev, Zdorov'ia, 1966. 253 p.
WF 200 D988t 1966 Cit. No. 41403

Nursing Advisory Service on TB and Other Respiratory Diseases. Exchange of ideas nation-wide 1963-1965. New York, National League for Nursing, 1965. iv, 203 leaves.
WY 163 N977e 1965 Cit. No. 41773

Todorov, Stefan. Tuberkuloza; prichini za razvitieto i, predpazvane i proiavi. Sofiia, Meditsina i fizkultura, 1966. 27 p. illus. (Biblioteka "Zdravni besedi za seloto," 1966, 5)
WF 200 T639t 1966 Cit. No. 42336

ULNA

Knussmann, Rainer. Humerus, Ulna und Radius der Simiae; vergleichend-morphologische Untersuchungen mit Berücksichtigung der Funktion. Basel, New York, Karger, 1967. ix, 399 p. illus. (Bibliotheca primatologica, fasc. 5)
W1 BI428T fasc. 5 1967 Cit. No. 41352

UNIVERSITIES

Kilian, Hermann Friedrich, 1800-1863. Die Universitaeten Deutschlands in medicinisch-naturwissenschaftlicher Hinsicht. Amsterdam, Israël, 1966. facsim.: v, 404 p. port. Enlarged reprint from the edition Heidelberg und Leipzig 1828.
W 19 K49u 1828F Cit. No. 41662

UROLOGIC DISEASES

Beltsikov, Josep. Uroloogilised haigused; nende vältimine ja ravi. Tallinn, Kirjastus Valgus, 1966. 51 p. (Teadus ja tervis)
W6 P3 Cit. No. 41533

VASCULAR DISEASES

Whelan, Thomas J. Non-atherosclerotic arterial lesions and their management [by] Thomas J. Whelan [and] Joseph H. Baugh. [Chicago, 1967] nos. illus. (Current problems in surgery, February, 1967, etc.)
W1 CU804S Feb. 1967 etc. Cit. No. 42351

VENA CAVA, SUPERIOR

Howard, Norman. Mediastinal obstruction in lung cancer. Edinburgh, Livingstone, 1967. vii, 100 p. illus.
WF 500 H851m 1967 Cit. No. 41744

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Strong, Charles L. Horses' injuries; common-sense therapy of muscles and joints for the layman. London, Faber and Faber [1967] 118 p. illus.
SF 901 S923h 1967 Cit. No. 41747

U. S. Agricultural Research Service. Health requirements and regulations governing the interstate and international movement of livestock and poultry, State [and] Federal. Revision Dec. 1965. [Hyattsville, Md., 1965] 1 v. (loose-leaf) (Its ARS 91-17-3)
SF 623 U58h 1965 Cit. No. 42066

Veterinarnye instrumenty, apparaty, pribory i oborudovanie; katalog. Moskva, V/O Medėksport [1966?] 259 p. illus. Added title pages in German, English, and French; contents in all four languages.
SF 913 V586 1966 Cit. No. 41517

VIBRATION

Angelova, Mariia. Vibratsionna bolest. Sofiia, Meditsina i fizkultura, 1966. 28 p. (Biblioteka "Zdravni besedi za rabotnika," 1906, 6)
WA 400 A58v 1966 Cit. No. 42355

Malinskaia, Nadezhda Nikolaevna. Profilaktika vibratsionnykh zabolevaniĭ. Moskva, Meditsina, 1966. 35 p. illus. (Nauchno-populiarnaia meditsinskaia literatura) At head of title: N. N. Malinskaia, N. B. Metlina.
W6 P3 Cit. No. 41427

VIRUSES

Kharizanova, Tania. Na granitsata na zh[illegible]ta. Sofiia, Narodna mladezh, 1966. 137 p. illus., ports. (Biblioteka za politekhnicheski znaniia, no. 29)
QW 160 K44n 1966 Cit. No. 41633

Kukaine, Rita, ed. Virus i kletka. [Redkollegiia: R. A. Kukain, otv. red., i dr.] Riga, Izd-vo Zinatne, 1966. 308 p. illus.
QW 160 K98v 1966 Cit. No. 41354

VITAMINS

Bersin, Theodor, 1902- Biochemie der Vitamine. Frankfurt a. M., Akademische Verlagsgesellschaft, 1966. 296 p. illus.
QU 160 B535b 1966 Cit. No. 41506

Malinov, Todor. Kak da su nabaviame vitamini prez vsichki sezoni. Plovdiv, Danov, 1966. 121 p. (Poreditsa Zdrave)
QU 160 M251k 1966 Cit. No. 41614

VIVISECTION

Dreyfus, Marie, comp. Crimes against creation. Trowbridge, Eng., Massey [1966] 322 p.
HV 4915 D778c 1966 Cit. No. 41137

VOCATIONAL GUIDANCE

Vaughan, Paul. Work to be done; careers in mental health. London, National Association for Mental Health [1966] 71 p. illus.
WM 21 V368w 1966 Cit. No. 41574

WATER POLLUTION

American Fisheries Society. A symposium on water quality criteria to protect aquatic life, presented at the 96th annual meeting, Kansas City, Missouri, September 1966. Edwin L. Cooper, editor. [Lawrence, Kan.] 1967. viii, 37 p. illus. (Its Special publication, no. 4) Supplement to vol. 96, no. 1 of Transactions of the American Fisheries Society.
W6 P3 Cit. No. 41212

California. State Water Quality Control Board. An investigation on the fate of organic and inorganic wastes discharged into the marine environment and their effects on biological productivity. [Sacramento] 1965. xi, 116 p. illus. (Its Publication, no. 29)
WA 778 C153i 1965 Cit. No. 37651

Colorado. Legislative Council. Water pollution in Colorado; Legislative Council report to the Colorado General Assembly. [Denver, 1965] xxix, 57 p. illus. (Its Research publication, no. 105)
WA 689 C719w 1965 Cit. No. 41210

WATER SUPPLY

Pan American Health Organization. Bombas para agua potable; apuntes del curso intensivo. Washington, 1966. vii, 269 p. illus. (Pan American Sanitary Bureau. Publicaciones científicas, no. 145)
W1 PA443 no.145 1966 Cit. No. 41657

Simposio sobre Agua Potable y Alcantarillado, Mexico, 1966. Memoria. [México, Secretaria de Recursos Hidráulicos, 1966] 454 p. illus., ports.
WA 670 S609m 1966 Cit. No. 42133

WOMEN

TSaneva, Nikolina. Khigiena na zhenata v proizvodstvoto. Sofiia, Meditsina i fizkultura, 1966. 26 p. (Biblioteka Zdravni besedi za rabotnika, 1966, 4)
WA 491 T877k 1966 Cit. No. 41317

WORK

Luk'ianov, Vladimir Sergeevich. Trud i zdorov'e. Moskva, Znanie, 1967. 44 p. (Narodnyĭ universitet. Fakul'tet zdorov'ia, 1967, 1)
W6 P3 Cit. No. 41647

WORKMEN'S COMPENSATION

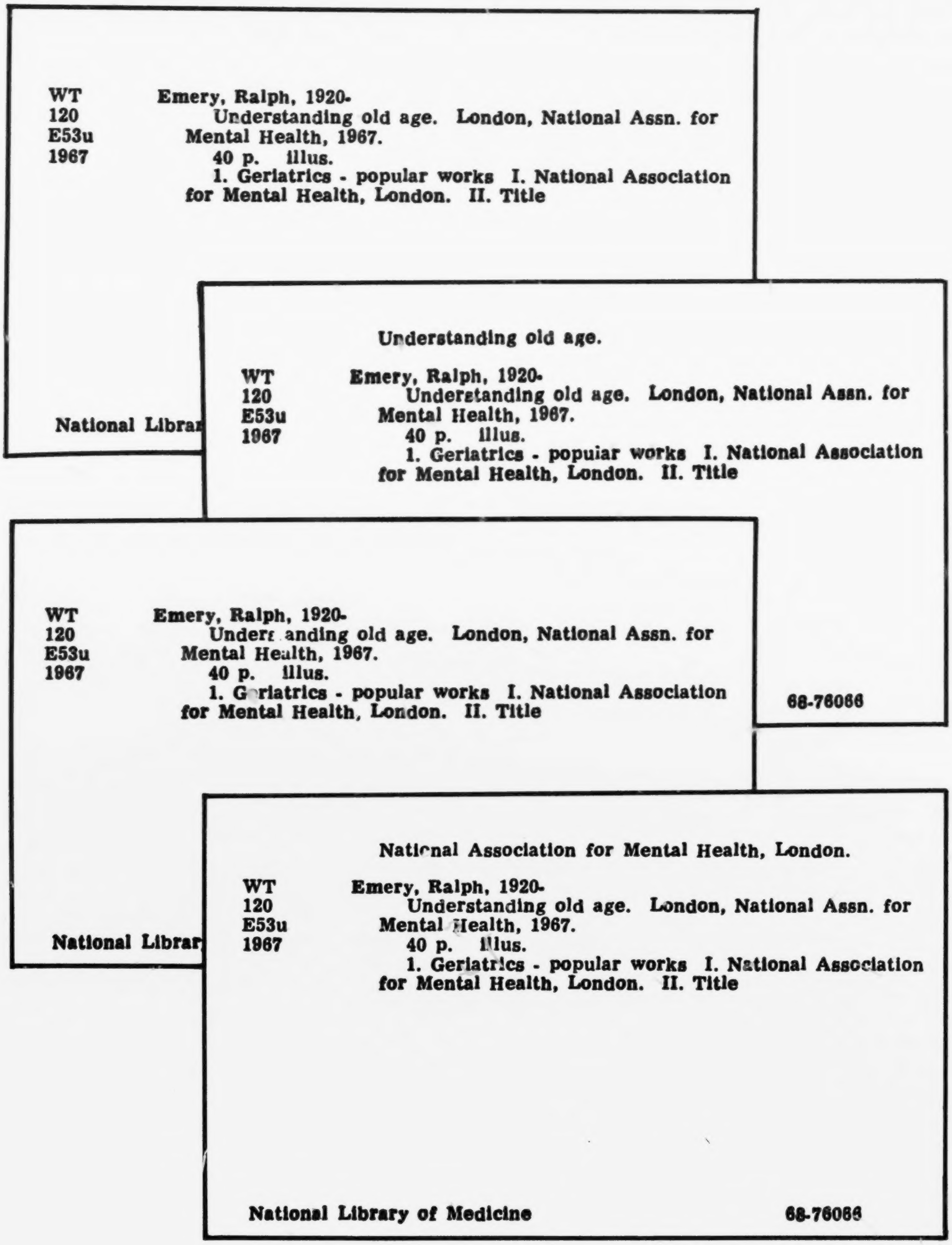
Braga, Marigildo de Camargo. Moléstias profissionais e doenças do trabalho. São Paulo, Editôra Aries [1966?]- v.
W 925 B813m Cit. No. 41326

Work injury cases settled under the Workmen's compensation act of Wisconsin: violations of safety rules and the Child labor law. 1965- Madison. v. Continues Injury cases settled under Workmen's compensation act of Wisconsin: violations of safety rules and the Child labor law. Issued by Industrial Commission of Wisconsin, Statistical Division as its Statistical release, 3804, etc.
W2 AW6 I4wd Cit. No. 41750

WOUNDS AND INJURIES

Jamieson, Kenneth G. Traffic injury in Brisbane; report of a general survey, by K. G. Jamieson and I. A. Tait. Canberra, 1966. xii, 353, ix p. illus. (Australia. National Health and Medical Research Council. Special report series, no. 13)
W2 KA8 N2s no.13 1966 Cit. No. 41375

FIGURE 30.—*Specimen Page of Biweekly* NLM Current Catalog.



WT Emery, Ralph, 1920-
120 Understanding old age. London, National Assn. for
E53u Mental Health, 1967.
1967 40 p. illus.
1. Geriatrics - popular works I. National Association
for Mental Health, London. II. Title

National Librar

Understanding old age.

WT Emery, Ralph, 1920-
120 Understanding old age. London, National Assn. for
E53u Mental Health, 1967.
1967 40 p. illus.
1. Geriatrics - popular works I. National Association
for Mental Health, London. II. Title

68-76066

WT Emery, Ralph, 1920-
120 Understanding old age. London, National Assn. for
E53u Mental Health, 1967.
1967 40 p. illus.
1. Geriatrics - popular works I. National Association
for Mental Health, London. II. Title

National Librar

National Association for Mental Health, London.

WT Emery, Ralph, 1920-
120 Understanding old age. London, National Assn. for
E53u Mental Health, 1967.
1967 40 p. illus.
1. Geriatrics - popular works I. National Association
for Mental Health, London. II. Title

National Library of Medicine 68-76066

FIGURE 31.—*Specimen Computer-Produced Catalog Cards.*

sets for each citation are produced by the computer for the central NLM file (see Figure 31). Cards are produced for the main entry and all added entries as well.

Except for the omission of price, information on the card is approximately the same as that in the book catalog. The format is that of a traditional catalog card, with appropriate indentations and call number in the left corner.

Equipment Used

The same basic equipment used for processing journal article citations is also used in the cataloging system. This includes the Flexowriter paper tape typewriters for input preparation, the Honeywell 800 and 200 computers for processing, and GRACE for output printing of both the book catalog and catalog cards. In addition, the system also makes use of a microfilm camera and Copyflo reproducer in the production of catalog cards, as described below.

Information Flow and Procedures

Figures 32 and 32a are charts showing the flow of information through the cataloging system.

The production of catalog cards and book catalogs is the joint responsibility of the Technical Services Division and the Office of Computer and Engineering Services. The catalogers' contribution is much the same as it has been; only now, the record of the traditional information is in machine-readable form.

Entries for both the biweekly and quarterly publications are in accordance with current American Library Association rules, with a few exceptions: only the Roman alphabet is used; titles in Cyrillic alphabets are cited in transliterated form only; titles in Oriental languages are translated as well. Average depth of subject cataloging is 1.5 subject headings per item.

Input data sheets (see Figure 33), prepared by the catalogers, are collected once a day, forwarded to the Office of Computer and Engineering Services, and typed in the form of hard copy and punched paper tape. The hard copies are visually proofread. The corrected hard copies are returned to the input typists for preparation of correction data.

Original paper tapes and correction paper tapes are spliced together. The correction paper tapes must always accompany the original tapes in the same input run to be properly processed by the computer.

The first six computer programs of the MEDLARS Input Module were modified to process cataloging data as well as journal article input data. The modified programs edit the citations and convert medical subject headings from English descriptors to their computer-coded equivalents.

Citations are checked within the computer for certain types of errors. Fields (authors, titles, etc.) incompatible with the input programs, with the exception of the subject headings field, cause the entire citation to be rejected. If subject headings are incorrect, the update program accepts the citation with the qualification that a "no-catalog card" flag is generated for that citation. This means that no catalog cards will be generated for the citation until file maintenance is performed to correct the erroneous subject headings on the citation. All rejected citations are listed with the reason for rejection.

All citations on the daily transaction tape, divided into main and subrecords for editing purposes, are sorted and merged into a unit record. Each citation is assigned a sequential number by the computer and is then merged into the cumulated catalog file (history); thus, the cumulated catalog file is in order by citation number. As daily transactions are merged into the history file, each citation is checked for a "generate catalog card" flag. Those citations containing this flag are copied on the card print file. The Card Expand Submodule is responsible for producing a complete set of cards. Each citation is expanded by as many index terms as are contained within the entry.

GRACE catalog card records are formatted on photographic paper for each card image, in 6-point upper- and lowercase font. The paper is then developed, inspected, and microfilmed. After developing the microfilm, the citations are enlarged to 8-point size and reproduced on the Xerox Copyflo machine. The cards are then cut to size, hole-punched,

COMPUTER-AIDED CATALOG SYSTEM FLOW CHART

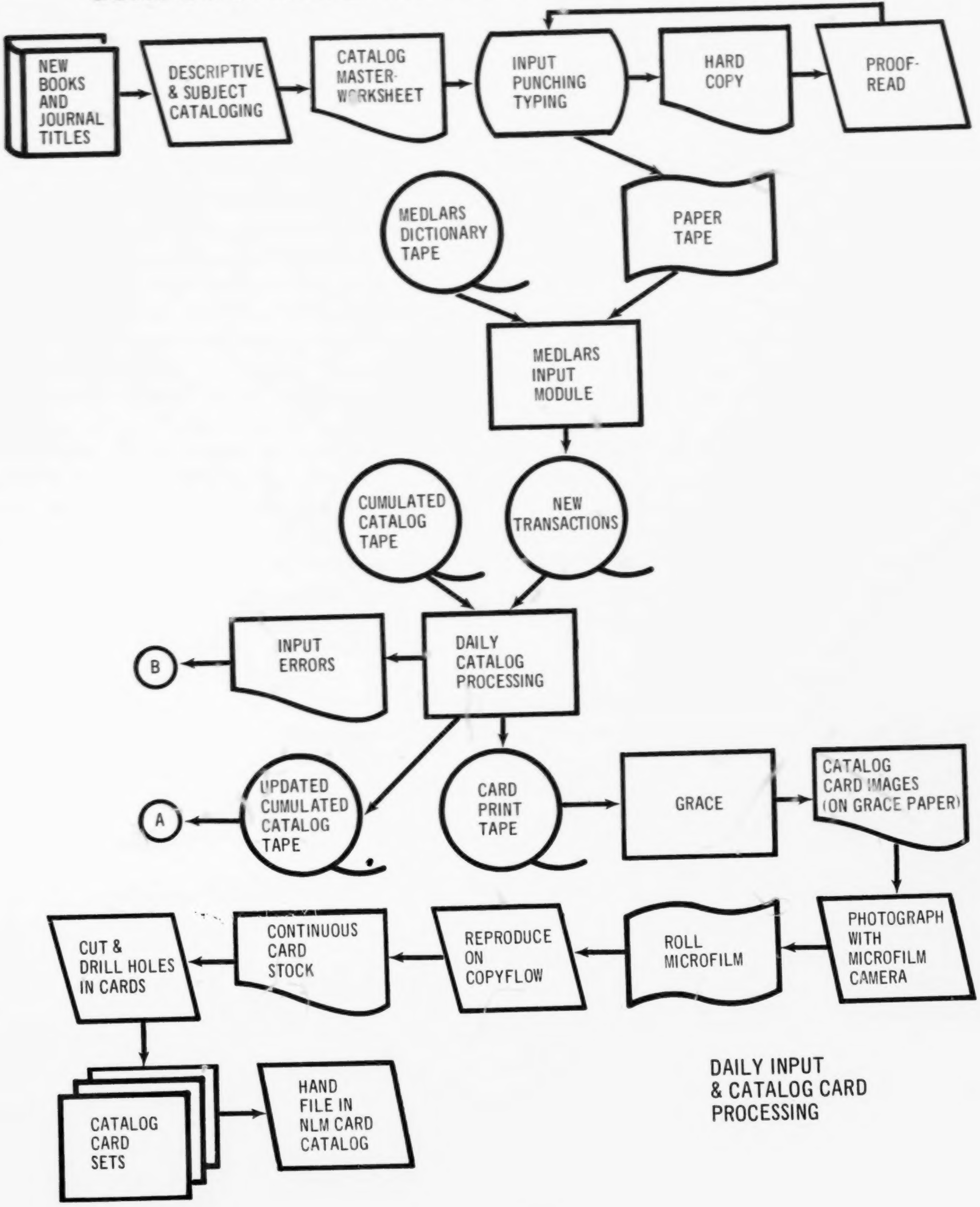

NEW BOOKS AND JOURNAL TITLES
DESCRIPTIVE & SUBJECT CATALOGING
CATALOG MASTER-WORKSHEET
INPUT PUNCHING TYPING
HARD COPY
PROOF-READ
MEDLARS DICTIONARY TAPE
PAPER TAPE
MEDLARS INPUT MODULE
CUMULATED CATALOG TAPE
NEW TRANSACTIONS
B
INPUT ERRORS
DAILY CATALOG PROCESSING
A
UPDATED CUMULATED CATALOG TAPE
CARD PRINT TAPE
GRACE
CATALOG CARD IMAGES (ON GRACE PAPER)
CUT & DRILL HOLES IN CARDS
CONTINUOUS CARD STOCK
REPRODUCE ON COPYFLOW
ROLL MICROFILM
PHOTOGRAPH WITH MICROFILM CAMERA
CATALOG CARD SETS
HAND FILE IN NLM CARD CATALOG
DAILY INPUT & CATALOG CARD PROCESSING

FIGURE 32.

COMPUTER-AIDED CATALOG SYSTEM FLOW CHART

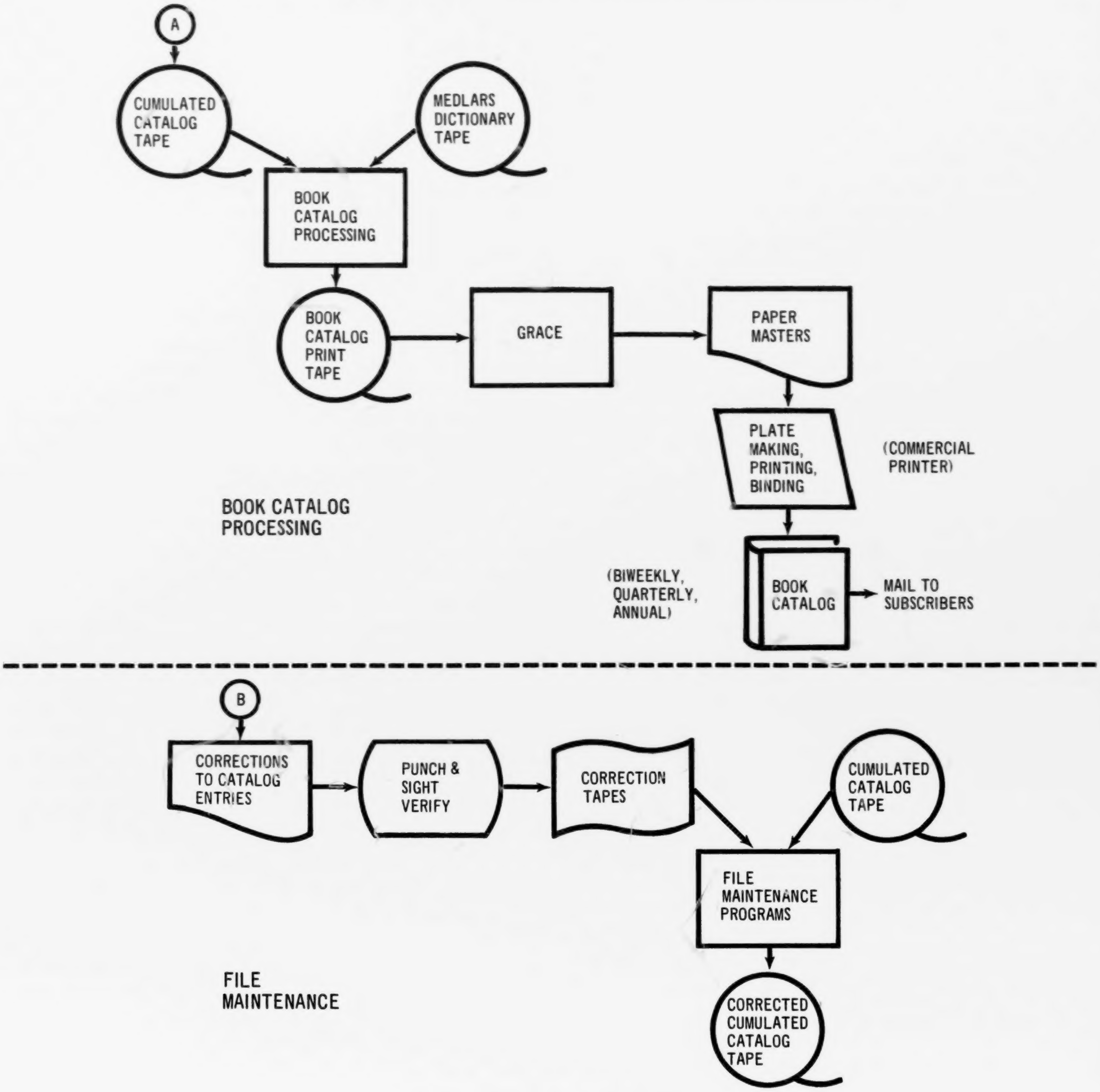
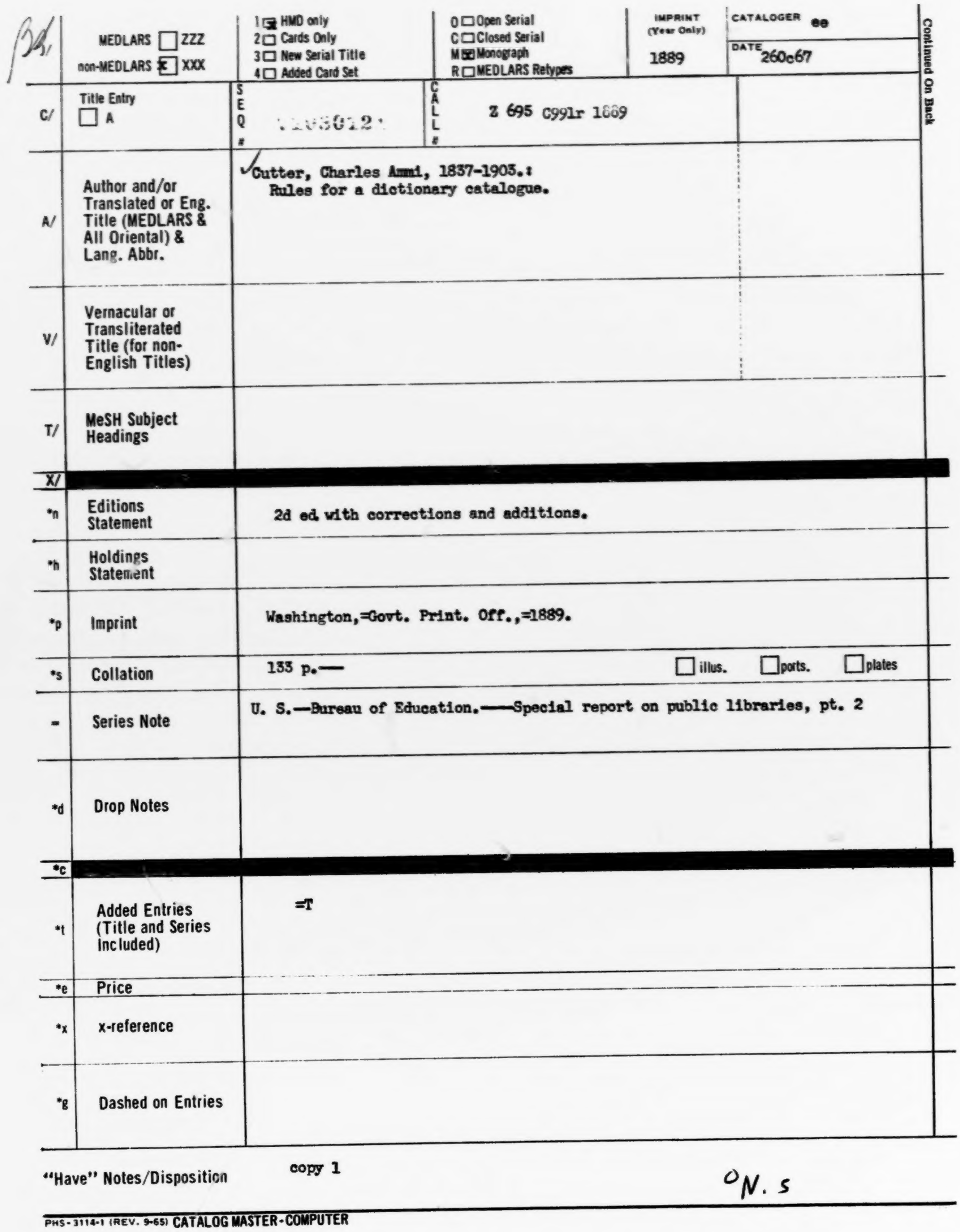

A
CUMULATED CATALOG TAPE
MEDLARS DICTIONARY TAPE
BOOK CATALOG PROCESSING
BOOK CATALOG PRINT TAPE
GRACE
PAPER MASTERS
PLATE MAKING, PRINTING, BINDING
(COMMERCIAL PRINTER)
BOOK CATALOG PROCESSING
(BIWEEKLY, QUARTERLY, ANNUAL)
BOOK CATALOG
MAIL TO SUBSCRIBERS
B
CORRECTIONS TO CATALOG ENTRIES
PUNCH & SIGHT VERIFY
CORRECTION TAPES
CUMULATED CATALOG TAPE
FILE MAINTENANCE PROGRAMS
FILE MAINTENANCE
CORRECTED CUMULATED CATALOG TAPE

FIGURE 32a.



Bd/

MEDLARS ☐ ZZZ
non-MEDLARS ☒ XXX

1 ☒ HMD only
2 ☐ Cards Only
3 ☐ New Serial Title
4 ☐ Added Card Set

O ☐ Open Serial
C ☐ Closed Serial
M ☒ Monograph
R ☐ MEDLARS Retypes

IMPRINT (Year Only) 1889

CATALOGER ee

DATE 260c67

Continued On Back

C/	Title Entry ☐ A	SEQ # [illegible] · CALL # Z 695 C991r 1889
A/	Author and/or Translated or Eng. Title (MEDLARS & All Oriental) & Lang. Abbr.	✓Cutter, Charles Ammi, 1837-1903.: Rules for a dictionary catalogue.
V/	Vernacular or Transliterated Title (for non-English Titles)	
T/	MeSH Subject Headings	
X/		
*n	Editions Statement	2d ed. with corrections and additions.
*h	Holdings Statement	
*p	Imprint	Washington,=Govt. Print. Off.,=1889.
*s	Collation	133 p.— ☐ illus. ☐ ports. ☐ plates
=	Series Note	U. S.—Bureau of Education.——Special report on public libraries, pt. 2
*d	Drop Notes	
*c		
*t	Added Entries (Title and Series Included)	=T
*e	Price	
*x	x-reference	
*g	Dashed on Entries	

"Have" Notes/Disposition copy 1

ON. S

PHS-3114-1 (REV. 9-65) CATALOG MASTER-COMPUTER

FIGURE 33.—*Sample Specimen Catalog Master (Input Data Sheet).*

and returned to the Catalog Maintenance Section for manual card finishing and filing in the Library's card catalog.

To produce a biweekly list, the coded equivalents for subject headings are converted back to natural language. The citations are expanded by the number of added entries and subject headings in each record. Only those citations flagged for the designated two-week period appear in any one biweekly *NLM Current Catalog*. The biweekly list is printed onto photographic film or paper which is developed, cut, inspected, and forwarded to a commercial printer, working under contract to the Government Printing Office. These biweekly issues of *NLM Current Catalog* are selective in coverage; that is, older, non-current materials are not included.

To produce a quarterly cumulated catalog, the coded equivalents for subject headings are converted, as for the biweekly list, to English subject headings. Citations are expanded for added entries and for author cross-references, and by subject headings. The quarterly cumulated lists include all materials cataloged by NLM regardless of imprint date, and are printed in the same manner as the biweekly issues.

As the catalog cards, the biweekly list, or one of the cumulated catalogs are inspected, errors may be detected. Any corrections needed are noted on correction data sheets. Corrections are made on the cards themselves, as was done in the past, or a new card set can be generated. In either case, the machine record in the cumulated catalog file is corrected.

The Library is in the process of converting part of the earlier catalog (pre-1966) to machine-readable form. Conversion of the 1965 catalog is underway, and consideration is being given to converting all material from 1960 (when MeSH was first used for cataloging) to 1964 as well. Availability of a machine-stored catalog will facilitate future systems for computer-aided acquisitions, searching, and reference activities.

Operating Experience

The computer-based cataloging system has been in operation since January 1966. Operating statistics for the first 24 months are shown in Table 8.

Throughput time for the catalog card is three days, measured from the time the catalog master is forwarded to the Input Section to the return of the catalog cards to the Catalog Maintenance Section. Throughput time for the biweekly is two work weeks, measured from the time when the *NLM Current Catalog* is produced by the computer, through the printing and mailing stages by the Government Printing Office. Throughput time for the cumulations varies from 17 workdays for the first quarterly to 43 workdays for the annual.

Table 8

Operating Statistics

Item	Statistics 1966	1967
Number of books cataloged	12,472	15,744
Number of catalog cards produced	115,850	156,213

Some operating problems were encountered. Probably the two most significant were (1) input errors occurring more frequently than estimated, requiring complete galley proofreading of each issue; and (2) great attention to detail required by the cataloger in preparing the input data sheet, which has increased cataloging time.

Chapter IX

SUMMARY

This report presents the final chapter on the current MEDLARS system at the point in time when the National Library of Medicine is on the verge of developing a new, more powerful approach to the problems of literature control and information retrieval in the biomedical sciences. This publication, together with the final report of the MEDLARS evaluation project* and the original MEDLARS story, presents a complete chronicle of the design and operation of one of the world's largest information retrieval systems.

MEDLARS was designed and operated according to conservative, well-established principles of documentation and information science. The most important of these were (1) the use of a controlled vocabulary for indexing and file searching; (2) the use of trained, professional indexers; and (3) serial organization of the search file on magnetic tape. The Library did not attempt to experiment with untested theories in designing the system, because of the large volume of literature to be processed and the number of users to be served. The conservative approach has resulted in four years of continued successful operation. What is more, there is no evidence of the system breaking down as the volume of literature increases, as some in this field predicted.

Many changes were made to MEDLARS during its four years of operation. The system was not static, and the major weaknesses that were discovered required system modifications. Some of the more significant changes included:

(1) Change of the basic information store from a two-file (one for publication, the other for demand search) to a single-file approach.

(2) Incorporation of topical subheadings which originally were not thought to be useful for this computer-based system.

(3) Change of the demand search input from punched paper tape to prepunched cards.

(4) Major revisions of the Demand Search and File Maintenance computer modules to improve operating efficiency.

MEDLARS is the only large-scale operating information retrieval system that has subjected itself to a rigorous, formal evaluation. This evaluation showed that the system was generally working well at a middle-of-the-road performance level in terms of recall and precision. Many important recommendations for improvement resulted from the evaluation. These included:

(1) User/system interaction needs to be improved; particularly important is a new and better Search Request Form.

(2) More use should be made of indexers and searchers in updating of MeSH, and less emphasis should be placed on outside experts.

(3) A better entry vocabulary is needed to allow effective selection of the proper MeSH terms in indexing and searching.

(4) Expanded use should be made of subheadings.

(5) Wherever applicable, use pre-established search strategies for concepts that re-occur in searching.

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*F. W. Lancaster, *Evaluation of the MEDLARS Demand Search Service*, National Library of Medicine, Bethesda, Maryland, 1968.

(6) The distinction between "depth" and "non-depth" journals for indexing should be eliminated.

Some of the Library's original objectives were met completely; others were not. In general, however, NLM was able to design and implement a large-volume production system capable of meeting the multiple requirements of published indexes and individual literature searches. Some of the original plans proved to be unrealistic—for example, the desired ability to provide two-day turnaround for demand searches.

The benefits of operating a system such as MEDLARS are many. Of particular importance is the experience gained from actually facing day-to-day operating problems. The personnel involved learn more each day and are much better qualified to move ahead in the design of more powerful new systems employing advanced techniques. Such is the situation in the Library today. The valuable lessons learned in the operation of MEDLARS are being applied to the design of a new system whose capabilities should be even more dramatic than those presented above. This report, therefore, serves both as a finale for the present MEDLARS and an overture for the exciting days ahead.

ca. 200

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